

2

DoD DISTRIBUTION STATEMENT

Approved for public release;
distribution unlimited

AD-A243 477



DTIC
S
C

RESEARCH & DEVELOPMENT

PROJECT SUMMARIES

OCTOBER 1991

NAVAL TRAINING SYSTEMS CENTER
12350 Research Parkway
Orlando, Florida 32826-3224

Approved for public release;
Distribution Unlimited

Approved:

H. C. OKRASKI
CHIEF SCIENTIST

W. S. CHAMBERS
TECHNOLOGY MANAGER

W. A. RIZZO
HEAD, HUMAN FACTORS DIVISION

91-16728



91 11 29 039

Van

REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.				
1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE October 1991	3. REPORT TYPE AND DATES COVERED Annual (Oct 91-Oct 92)		
4. TITLE AND SUBTITLE Research & Development Project Summaries, October 1991		5. FUNDING NUMBERS		
6. AUTHOR(S) Editor - Bobbie Petersen				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Training Systems Center Central Florida Research Park 12350 Research Parkway Orlando, FL 32826-3224		8. PERFORMING ORGANIZATION REPORT NUMBER NTSC-91-01		
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) N/A		10. SPONSORING/MONITORING AGENCY REPORT NUMBER N/A		
11. SUPPLEMENTARY NOTES				
12a. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited		12b. DISTRIBUTION CODE A		
13. ABSTRACT (Maximum 200 words) This brochure presents brief summaries of the FY92 research efforts at the Naval Training Systems Center (NAVTRASYSCEN) in Orlando, FL. NAVTRASYSCEN has comprehensive simulation and training systems responsibilities ranging from research and technology base development through system acquisition and life cycle support. The NAVTRASYSCEN is unique in this integrated role because it performs research, specifies the training device's engineering, instructional, and operational requirements, selects the contractor, evaluates the trainer as it is being built, and ensures the trainer can be properly operated and maintained in the field. In addition to the Navy, NAVTRASYSCEN provides services for the Marine Corps, Army, Air Force, and foreign governments. The NAVTRASYSCEN's research mission is to plan and perform a full range of directed research and development in support of Naval training systems for all warfare areas and platforms, to maintain an expanding technology base, and to transition research results to the fleet. R&D program emphasis is on fleet and training command requirements, rapid transition of products, industry/university coordination, improved planning, coordination with other services, and improved quality and cost effectiveness of products.				
14. SUBJECT TERMS Helmet Mounted Displays; Flight Simulation; Visual Display Technology; Team Training; Embedded Training; Part Task Training; Human Factors Engineering			15. NUMBER OF PAGES 72	
			16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT SAR	

GENERAL INSTRUCTIONS FOR COMPLETING SF 298

The Report Documentation Page (RDP) is used in announcing and cataloging reports. It is important that this information be consistent with the rest of the report, particularly the cover and title page. Instructions for filling in each block of the form follow. It is important to *stay within the lines* to meet optical scanning requirements.

Block 1. Agency Use Only (Leave blank).

Block 2. Report Date. Full publication date including day, month, and year, if available (e.g. 1 Jan 88). Must cite at least the year.

Block 3. Type of Report and Dates Covered. State whether report is interim, final, etc. If applicable, enter inclusive report dates (e.g. 10 Jun 87 - 30 Jun 88).

Block 4. Title and Subtitle. A title is taken from the part of the report that provides the most meaningful and complete information. When a report is prepared in more than one volume, repeat the primary title, add volume number, and include subtitle for the specific volume. On classified documents enter the title classification in parentheses.

Block 5. Funding Numbers. To include contract and grant numbers; may include program element number(s), project number(s), task number(s), and work unit number(s). Use the following labels:

C - Contract	PR - Project
G - Grant	TA - Task
PE - Program Element	WU - Work Unit Accession No.

Block 6. Author(s). Name(s) of person(s) responsible for writing the report, performing the research, or credited with the content of the report. If editor or compiler, this should follow the name(s).

Block 7. Performing Organization Name(s) and Address(es). Self-explanatory.

Block 8. Performing Organization Report Number. Enter the unique alphanumeric report number(s) assigned by the organization performing the report.

Block 9. Sponsoring/Monitoring Agency Name(s) and Address(es). Self-explanatory.

Block 10. Sponsoring/Monitoring Agency Report Number. (If known)

Block 11. Supplementary Notes. Enter information not included elsewhere such as: Prepared in cooperation with...; Trans. of...; To be published in.... When a report is revised, include a statement whether the new report supersedes or supplements the older report.

Block 12a. Distribution/Availability Statement. Denotes public availability or limitations. Cite any availability to the public. Enter additional limitations or special markings in all capitals (e.g. NOFORN, REL, ITAR).

DOD - See DoDD 5230.24, "Distribution Statements on Technical Documents."

DOE - See authorities.

NASA - See Handbook NHB 2200.2.

NTIS - Leave blank.

Block 12b. Distribution Code.

DOD - Leave blank.

DOE - Enter DOE distribution categories from the Standard Distribution for Unclassified Scientific and Technical Reports.

NASA - Leave blank.

NTIS - Leave blank.

Block 13. Abstract. Include a brief (*Maximum 200 words*) factual summary of the most significant information contained in the report.

Block 14. Subject Terms. Keywords or phrases identifying major subjects in the report.

Block 15. Number of Pages. Enter the total number of pages.

Block 16. Price Code. Enter appropriate price code (*NTIS only*).

Blocks 17. - 19. Security Classifications. Self-explanatory. Enter U.S. Security Classification in accordance with U.S. Security Regulations (i.e., UNCLASSIFIED). If form contains classified information, stamp classification on the top and bottom of the page.

Block 20. Limitation of Abstract. This block must be completed to assign a limitation to the abstract. Enter either UL (unlimited) or SAR (same as report). An entry in this block is necessary if the abstract is to be limited. If blank, the abstract is assumed to be unlimited.

TABLE OF CONTENTS

	PAGE
EXECUTIVE SUMMARY	1
TRAINING DEVICES TECHNOLOGY (PE 0603733N)	3
Aircrew Coordination Training	4
Forward Deployable Aviation Simulator Technology	5
Organic Combat Systems Training Technology.	6
SIMULATION & TRAINING DEVICES TECHNOLOGY (PE0602233N)	7
Instructional Technology	
- Radio Instruments Orientation Trainer	8
- Aircrew Coordination and Performance	10
- Retention of Trained Skills	12
- Embedded Training Technology Identification and Development	13
- Aircrew Instructional System.	14
Simulation Technology	
- Simulation of Advanced Sensors	16
- CIG Cost/Performance Enhancement	18
- Synthesis of Active Acoustic Signals and Displays for Trng.	19
- Moving Weapons Simulation Technology.	21
- Crystal Target Projector	22
- Tactical Training Instructor Components	23
- Advanced Computing Applications	25
Virtual Environment Training Technology	26
Tactical Decision Making Under Stress	28
INDEPENDENT RESEARCH (PE 0601152N) AND	30
INDEPENDENT EXPLORATORY DEVELOPMENT) (PE 0602936N)	
Independent Research	
- Trainability Factors in Training System Design	31
- Tactical Behavior Modeling Using Neural Networks	33
- Distributed Decision Making: Implications for Training	35
Independent Exploratory Development	
- Low Cost Aviation Vision Trainer	37
- Assessment of Implementation Methods in Ada Tasking for Simulation.	38
- Assessment of the Training Effectiveness of Dual Display	40
Computer Based Training for Weapons Systems with Generic Man-Machine Interfaces	
- Computer-Aided Engineering Specification Editing Tools	42
- Real-Time ESM Simulation Signal Generation with COTS Hardware	44

TABLE OF CONTENTS (CON'T)

	PAGE
JOINT SERVICES R&D PROGRAM (PE0604722)	46
Weapons Team Engagement Simulation	47
SMALL BUSINESS INNOVATIVE RESEARCH (PE 0605502N)	49
FY92 Phase I	
- Texture Modeling Techniques for Simulation of	50
Infrared Sensor Displays for Mission Practice in	
Night/Low Visibility Conditions	
- Knowledge-based Intelligent Tutoring System Development.. . . .	50
Tool for Tabletop Training Systems	
- Gas Mask Sensor to Detect Whether Mask is	51
Fully Sealed	
- High Definition TV Projection via Single Crystal CRT	51
Faceplate Technology	
- Low Cost Head/Helmet Mounted Display for Simulation	52
- Low Cost System for Verification of the Cueing.	52
Fidelity of a Total Simulator	
- Subject Matter and Pedagogical Experts for Training.	53
Device Curriculum Development and Control	
- Low Cost Automatic Scenario Generator	53
FY92 Phase II	
- Training Optimized Utilization Resource Scheduler	54
- On-Line Diagnostic System for Simulator	55
Performance Monitoring	
- Real-Time Photographic Based Terrain Image	57
Generator for 3-D Objects	
- Low Cost Reconfigurable Cockpit for	58
Deployable Aircrew Team Trainers	
- Low Cost Computer Image Generator for Night Vision.	59
- Low Cost Night Vision Goggles for Simulation	60
ANCILLARY FUNDED PROJECTS	61
- Electronic Warfare Continuum Assessment Program	62
- Productivity Enhancing Capital Investments	63
- Simulator Sickness R&D Program	65
TECHNOLOGY TRANSFER INITIATIVES.	66
APPENDIX (Terms of Reference)	69

EXECUTIVE SUMMARY

The Naval Training Systems Center (NAVTRASYSCEN) has comprehensive simulation and training systems responsibilities ranging from research and technology base development through system acquisition and life cycle support. The NAVTRASYSCEN is unique in this integrated role because it performs research, specifies the training device's engineering, instructional, and operational requirements, selects the contractor, evaluates the trainer as it is being built, and ensures the trainer can be properly operated and maintained in the field. In addition to its mission as the principal Navy activity for development of training systems, NAVTRASYSCEN provides services for the Marine Corps, Army, Air Force, and foreign governments.

The NAVTRASYSCEN's research mission is to plan and perform a full range of directed research and development in support of Naval training systems for all warfare areas and platforms, to maintain an expanding technology base, and to transition research results to the fleet. R&D program emphasis is on fleet and training command requirements, rapid transition of products, industry/university coordination, improved planning, coordination with other services, and improved quality and cost effectiveness of products. Needs for Naval service training systems are determined by the warfare area sponsors for training and training systems under the Chief of Naval Operations and Chief of Marine Corps. These needs are generated by new weapon system developments, by modifications to existing weapon systems, and by fleet requirements for new training systems and capabilities to satisfy specific training tasks. Thus, the R&D program is balanced between improvements in highly specialized areas of simulation, training methods, training technology, and providing direct technical support to the training systems acquisition effort, especially in simulation engineering, instructional delivery methods, training cost reduction, demonstration of technology effectiveness, and the reduction of acquisition risk.

The majority of the work undertaken constitutes the Technology Base Program and includes exploratory development (6.2), where feasibility and conceptual research plans are determined, and advanced development (6.3A), where proof-of-concept is established. Additional efforts include cooperative/collaborative research with other government agencies, non-profit institutions, and commercial firms. Funds are received from the following activities: the Office of the Chief of Naval Research, Naval Air Systems Command, the Joint Services Manpower and Training Systems Committee, Naval Air Test Center, Space and Naval Warfare System Command, Air Force Human Resources Lab, and the National Guard Bureau.

NAVTRASYSCEN has a long history of technology transfer to both the public and private sectors. Several software programs have been developed and provided to schools, both locally and nationwide. NAVTRASYSCEN has adopted a school system and will provide services to enhance the training for the students. Information is also being shared with NASA, Kennedy Space Center, the Orange County Sheriff's office, and the Orlando Fire Department. There are currently two Cooperative Research and Development Agreements (CRDA) and two more are in progress. CRDAs provide for the transfer of technology developed in federal government laboratories to the private sector. By sharing Navy training research, the public will benefit in having improved education and training. The Navy also receives valuable information in the exchange of information and resources.

The researchers and engineers in the Research and Engineering (R&E) Department at NAVTRASYSCEN work closely together to promote transitions of promising technology and to resolve problems that occur in acquisition programs or with fielded trainers. The majority of the

research is conducted by two R&E divisions, although other divisions also perform research efforts. The two divisions are:

Advanced Simulation Concepts Division - Conducts R&D on improvements to the fidelity, cost and training effectiveness of image generation and display systems for training; researches, develops, and tests new concepts in low cost computer-based simulation; conducts R&D related to providing the physical stimuli that simulate the operational equipment; performs and directs computer applications research for warfare operations related training systems to improve training capabilities and cost effectiveness; and operates and maintains shop facilities to fabricate, repair or modify experimental mechanical and electro-mechanical devices for use in R&D projects. The Visual Technology Research Simulator, the test-bed for visual simulation technology, is in this division.

Human Factors Division - Develops and advances the basic knowledge required to provide the foundation for human factors applications to training systems; and conducts laboratory and field research to determine the degree to which new technology may be applied in the design of innovative training systems.

This brochure presents brief summaries of the FY92 research efforts at NAVTRASYSCEN. Its purpose is to inform anyone who has an interest in training simulation technology of the research being performed at NAVTRASYSCEN. For more information on the individual tasks, please call or write the principal investigator shown with each task. Copies of this brochure and summaries of each individual task are available from the Defense Technical Information Center (DTIC). The DTIC accession number is provided for each task that has a work unit summary on file. For information on obtaining copies from DTIC, call or write to:

Defense Technical Information Center
Office of User Services and Marketing
Bldg. 5, Cameron Station
Alexandria, VA 22304-6145
(202)274-6434/AUTOVON 284-6434

The brochure is organized as follows:

- Advanced Development
- Exploratory Development
- Independent Research and Independent Exploratory Development
- Joint Services R&D Program
- Small Business Innovative Research
- Tasks funded by other Navy activities
- Technology Transfer

**SIMULATION & TRAINING DEVICES
PROGRAM ELEMENT 0603733N**

The objective of this program element is to conduct proof-of-concept demonstrations, risk reduction developments, and cost-effectiveness investigations in simulator and training technology. This advanced development program is a continuing effort to improve fleet readiness through development, demonstration, and transition of simulation and training device technology to acquisition programs. In recent years, along with significant increases in the complexity of weapons systems have come increasing requirements for more advanced simulation and training technology.

The program is based on requirements established by the Chief of Naval Operations (CNO). It is designed to improve the integration of technologies that support weapons and training system development, including all aspects of the research, development and acquisition process from technology development and demonstration, to systems requirements analysis, design, test and evaluation, and support for deployed systems. The program is organized around specific demonstration tasks that target critical technical risks that confront future weapons system acquisition programs. The demonstration tasks are carefully selected to focus attention on a problem and a solution, and to complement significant R&D investments made in the simulation industry. CNO has assigned the responsibility for program management and technical direction to the Naval Air Systems Command, who has tasked NAVTRASYS-CEN for program execution.

The simulation and training devices program entails a balance between "technology push" and "requirements pull." The focus of the program is on demonstrations of technology for a wide variety of applications, from portable part-task trainers up to and including fullscale high-fidelity weapons system simulations, and battle-force combat simulations.

NAVTRASYSCEN has three projects under this program element, as follows:

- **Aircrew Coordination Training:** The objectives of this work are to develop an integrated, validated methodology for training crews in coordination, develop a proof-of-concept training system, and to establish draft specifications for aircrew coordination training and for evaluation of that training based on that methodology.
- **Forward Deployable Aviation Simulator Technology:** The objective of this effort is to develop design guidelines for deployable aircrew trainers for critical flight tasks and mission rehearsal. This project will provide integrated demonstrations of key technology components which present risk areas critical to the success of transition to the Deployable Tactical Aircraft Training System (DTATS) planned for FY94.
- **Organic Combat Systems Training Technology:** The objective is to develop technology to reduce the cost associated with training systems, including embedded and shorebased, and to demonstrate the results.

APPROVED FOR
 BY: ORADA
 DTIC TAB
 UNCLASSIFIED
 Justification
 of
 Classification
 Authority: [unclear]
 Date: [unclear]
 A-1

AIRCREW COORDINATION TRAINING..

Principal Investigator - C. Prince

Code 26 Phone: 407/380-4831

DTIC Agency Accession Number: DN700014

BACKGROUND: Aircraft incidents and accidents caused by human error in the cockpit provide compelling justification for the introduction of more effective aircrew training. Recently, the proportion of incidents and accidents attributed to human error is estimated to be between 60% and 80%. Analysis of these errors reveals that they are not due to a lack of technical knowledge in how to fly a plane, but to failure of the pilot to optimize cockpit resources, particularly aircrew resources. Poor aircrew coordination compromises not only flight safety but also effective mission performance. These two factors, safety and performance, have resulted in a new emphasis on training in cockpit resource management, particularly in response to unusual situations. The aviation industry and military have responded to this need by developing crew coordination programs, but little effectiveness research has been conducted.

OBJECTIVE: The objectives of this work are to develop an integrated, validated methodology for training crews in coordination, develop a proof-of-concept training system, and to establish specifications for aircrew coordination training and for evaluation of that training. This work builds on the aircrew coordination framework and instructional technologies developed under the 6.2 Aircrew Coordination and Performance task.

BENEFITS: The operational benefits from this task will be an improved aircrew coordination resulting in increased mission effectiveness and reduced accident rates in all manned airborne weapons systems. Prevention of a single aircraft accident attributable to poor crew coordination will provide significant return on investment based on the cost of the program compared to saving even a single aircraft.

STATUS: A prototype program of ACT, composed of eight modules, demonstrating the NAVTRASYS SCEN methodology has been developed for the CH-46 and for the CH-53. Demonstration of the first three modules of the CH-53 program was conducted at Tustin, MCAS, and a demonstration of the methodology for the program was conducted at New River, MCAS. Needs analyses for the A-6, F-14, and T-44 communities have begun. Interviews have been conducted, training sessions observed, simulators visited, and a survey form for the A-6 and F-14 is being completed. An experiment using table top simulation with the T-44 students and instructors is nearing completion. Its results will provide information on the validity of the identified skills for ACT and on their measurement.

MAJOR MILESTONES:

Phase I Module Demonstrations
Phase I Evaluation Report
Phase II Module Demonstrations
Phase II Evaluation Report

FY91
FY91
FY92
FY93



FORWARD DEPLOYABLE AVIATION SIMULATOR TECHNOLOGY

Principal Investigator - W. Chambers

Code 2B Phone: 407/380-8137

DTIC Agency Accession Number: TBD

BACKGROUND: Aircrews deployed on aircraft carriers lack a facility for recurrent training in critical flight skills and for conducting mission rehearsal exercises. These deployed aircrews must utilize operational aircraft to enhance and maintain skills since current training facilities are confined to large shore based installations. The use of operational aircraft is expensive, provides only limited training opportunities for advanced weapons procedures, and does not provide a significant mission rehearsal capability. The simulator industry does not have test beds to demonstrate integrated multisource components or to evaluate the training effectiveness of the advanced training hardware it develops. The Navy's aviation simulation test beds can demonstrate the feasibility of new design concepts and reduce the risk associated with integrating these concepts.

OBJECTIVE: The objective of this effort is to develop design guidelines for deployable aircrew trainers for critical flight tasks and mission rehearsal. This task will provide integrated demonstrations of key technology components which present risk areas critical to the success of transition to the Deployable Tactical Aircraft Training System (DTATS) planned for FY94. These areas include low cost reconfigurable cockpits and threat simulations for deployed applications, helmet mounted visual displays, simulator networking for interactive crew coordination, and cost effective photo-based image generators.

BENEFITS: Evaluation of advanced technology components will substantially reduce the cost and risk of acquiring DTATS. Furthermore, the hands-on experience provided to aircrews will greatly facilitate the refinement of the performance requirements for DTATS.

STATUS: This is a new start for FY92. The task is utilizing work performed under three tasks that have been consolidated. The three tasks were Carrier Based Training System, Photographic Database Projection, and Hands on Throttle and Stick Part Task Trainer.

MAJOR MILESTONES:

Demonstrate Simulator Concepts	FY92
Evaluate Technology Components for Strike Mission Acceptability	FY92/FY93
Evaluate Mission Computer Simulation/ Stimulation	FY93
Demonstrate Mission Rehearsal Components	FY93

ORGANIC COMBAT SYSTEMS TRAINING TECHNOLOGY

Principal Investigator - R. Stratton

Code 25 Phone: 407/380-4587

DTIC Agency Accession Number: DN701012

BACKGROUND: Shorebased training systems are becoming more complex and more expensive each year. As a supplement to shorebased training, shipboard embedded training provides a key element of the training continuum. Battle force tactical training is a high priority training requirement that can be met by developing shipboard embedded training systems with flexible ship-to-ship connectivity and at a cost that is affordable for a large number of ships. In addition to embedded training, there is a need for a performance measurement capability at all levels, i.e., individual unit, battle group, and battle force.

OBJECTIVE: The overall objective of this effort is to find ways to reduce the costs associated with all training systems, including embedded and shorebased, and to demonstrate the results. "Cost" in this context refers not only to direct dollar cost for acquisition, but also to other costs such as logistic costs, operational costs, manpower costs associated with operation and support, and other costs not as visible as acquisition costs.

BENEFITS: This task will develop products that will transition embedded training technology to a battle force training systems architecture. The payoff is improved readiness at low cost through innovative technology. It will also reduce trainer costs by identifying reusable software modules, increase trainer efficiencies by development of faster math/simulation models of targets, and increase utilization of trainers by the addition of instructional support enhancements.

STATUS: The Pierside Combat System Team Trainer (Device 205B) software for the FFG-7 class Frigate is being rehosted on Gould 3267 and Motorola 88000 micro-computers. Hardware and software redesign of Device 20B5 Instructor/ Operator Station is underway. Two AN/UYK-43's, peripherals, and control consoles were acquired and installed for hosting the shipboard Combat Direction System (CDS). FFG-7 CDS and simulation system software were installed. Systems integration will be completed in FY92.

MAJOR MILESTONES:

Single Ship Tactical Environment	FY92/FY93
Embedded Training	
Instructional Features	FY93
Demonstration	
Performance Measurement and	FY93
Evaluation System Dev, Test & Eval,	
and Demo	
Demonstrate Networking Capability	FY93
Multi-ship Capability Demonstration	FY95

SIMULATION & TRAINING DEVICES TECHNOLOGY PROGRAM ELEMENT 0602233N

The objective of this exploratory development is to provide mission support technologies essential for all naval operations through the development of training device simulation technology. The Office of Naval Technology mission area for training systems is concerned with improving the training effectiveness of Navy training devices, lowering their costs, and extending training device applicability into more training domains. The technology being developed will enhance visual and sensor simulation capabilities, provide advanced computer hardware and software concepts for greater real-time simulation capabilities, improve the instructional value of simulation systems, and define the necessary functional characteristics of training devices.

NAVTRASYSSEN has four projects under this program element, as follows:

- Instructional Technology: Objectives of this project are to improve the Navy's ability to train personnel effectively, rapidly, and economically. These objectives are met by developing state-of-the-art technology for: computer-based intelligent training systems; communication and problem solving skills; individual and group performance measurement; and cost-effective simulators and training devices.

- Simulation Technology: The objective of this project is to provide the trainee or training team with a simulated environment in which they can learn and exercise their required skills in a realistic, cost effective manner. This objective is met by developing and demonstrating the feasibility of technologies for improving the training effectiveness and reducing the cost of environment and operational equipment simulation systems in training devices for weapon system, platform, and sensor operators.

- Virtual Environment Training technology. The objective of this project is to demonstrate the feasibility of VE-based training and evaluate the potential for improving cost and training effectiveness of training through VE-based training systems. Although a fully developed VE training system interface would be applicable to all training scenarios, the current state of the art of VE technology is such that full development is not expected for 5-10 years. In the meantime, there are training applications which can be investigated within the current limitations of VE interface performance.

- Tactical Decision-Making Under Stress: The objective of this project is to apply recent developments in decision theory, individual and team training, and information display to the problem of enhancing tactical decision quality under conditions of stress. The objective will be accomplished through developing decision support principles, training and simulation principles, and display principles.

RADIO INSTRUMENTS ORIENTATION TRAINER (RIOT)

Principal Investigator - R. Garris

Code 26 Phone: 407/380-4833

DTIC Agency Accession Number: DN708013

BACKGROUND: The RIOT was initiated to help overcome orientation and task overloading problems encountered by student naval aviators (SNA) during the radio instruments (RI) phase of primary flight training. The average SNA experiences problems during RI training because basic flying tasks interfere with performance of the difficult instrument navigation tasks. The RIOT, a microcomputer-based part-task trainer, offers a low-cost method for SNAs to acquire RI skills without interference from basic aircraft control tasks required in the operational flight trainer and T-34C aircraft. This effort will demonstrate low-cost, part-task approaches for future developments.

OBJECTIVE: This task will help define simulation/training limits of microcomputers for use in low-cost, part-task trainers. Initial research focused on simulation features and instructional approaches for the RIOT. Subsequent efforts will evaluate the potential of incorporating the RIOT into the primary flight training curriculum. This research will help define design guidelines for future low-cost, part-task trainer developments.

BENEFITS: Success of the RIOT effort includes: a) improved student performance on orientation problems, b) decreased costs of primary flight training, c) reduced need for a dedicated instructor, d) increased standardization and individualization of instruction, e) capabilities to analyze student data to identify improvements for the overall training curriculum, and f) uses for the RIOT (with relatively minor software modifications) for other applications (e.g., to train flight instructors, as an aid to an instructor in the classroom).

Preliminary analyses show potential cost benefits. One complete RIOT system costs less than \$10,000, which may be reduced further with the purchase of multiple systems. The RIOT should reduce the extra training (ET) time required both in the simulator and the T-34C. Reductions in remedial simulator and aircraft time will reduce training costs. For example, approximately 1500 hours of ET in the T-34C are required annually during primary flight training at NAS Whiting Field. An estimated one-fourth of this ET is used for overcoming RI deficiencies. If the RIOT alleviates these approximately 375 ET hours, the savings in maintenance, fuel costs, and other support for the T-34C (approximately \$357.00 per hour) would be over \$133,875 per year (source: VAMOSC-AIR Total Support System Report - 15 Sep 87). If instructor and simulator time savings also are taken into consideration, both at NAS Whiting Field and the other primary flight training sites in the Navy and Air Force, a significantly greater cost savings would result.

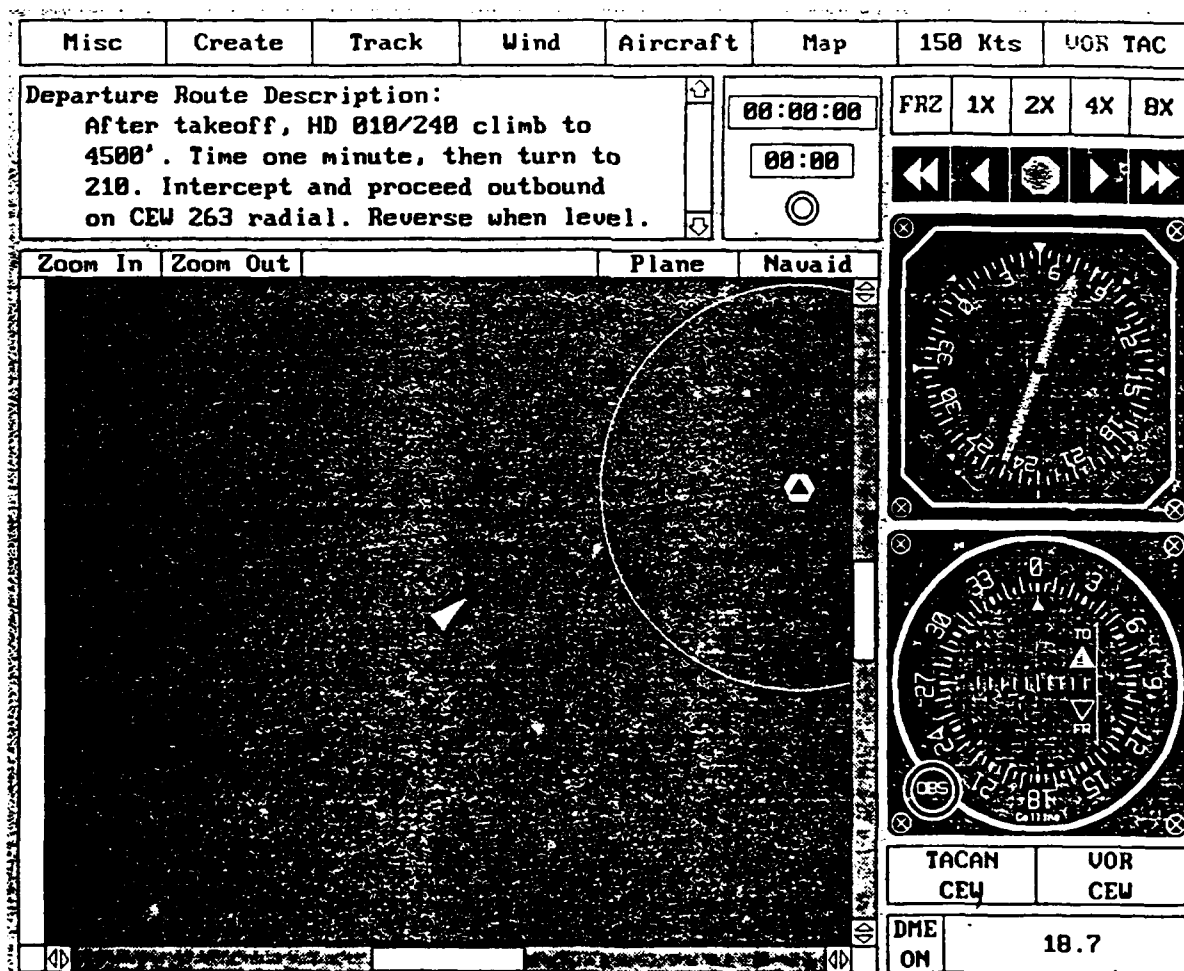
STATUS: As it exists now, the RIOT can be described as a teaching tool composed of a personal computer and a graphics monitor. Fully functional radio navigation instruments and a bird's-eye view of the T-34C aircraft ground track are displayed. A menu bar across the top of the screen provides training and control options to the SNA. The RIOT hardware is composed of off-the-shelf components: a PC-AT compatible personal computer, a high resolution graphics subsystem and a mouse. The RIOT software is written in the "C" programming language, and is composed of interrupt-driven and polled processes.

The formative evaluation was designed to serve as a shakedown of RIOT, the evaluation instruments, and the evaluation procedures, and to assist in the identification of other potential instructional features that may be of benefit to RI students. Data gathered and lessons learned have enhanced the design of the final evaluation. In addition, new instructional features have been

identified and most have already been implemented. NAS Whiting Field currently has two desk-top versions of RIOT for use by students. In addition, a RIOT system with a projector has been installed for classroom use by the flight support instructors. A RIOT system has been loaned to the Air Force at Randolph AFB, where an evaluation by instructor pilots is scheduled. TRAWINGSIX NAS Pensacola (Naval Flight Officer community) sees immediate application for RIOT and is seeking funding for implementation.

MAJOR MILESTONES:

Complete Training Effectiveness Evaluation	FY92
Publish Final Report	FY92
Transition to Fleet	FY92



AIRCREW COORDINATION AND PERFORMANCE

Principal Investigator - C. Prince

Code 26 Phone: 407/380-4831

DTIC Agency Accession Number: DN709006

BACKGROUND: The coordinated performance of aircrews for mission safety and success has become an issue of concern for military training. Research has shown problems stemming from insufficient skills in effective management of cockpit resources. Accident and incident investigation has revealed that 60 percent of all accidents are caused by problems with decision making, leadership, judgment, communication and crew coordination. Improved training of aircrews in task coordination is necessary for crew performance effectiveness, air combat maneuvering, and operational readiness. Current aircrew training emphasizes specific, necessary skills and is not designed to provide experience with crew coordination. This research effort will identify crew coordination factors that lead to effective performance, as well as the factors that contribute to a failure of coordination. Emphasis will also be placed on the need for standardized, objective, and relevant aircrew performance measurement as a natural corollary to the aircrew training issue.

OBJECTIVE: Objectives of this task are to define and assess aircrew coordination skills, develop performance measures indicative of crew performance, and develop technology to support training.

BENEFITS: This effort will provide: (a) a framework to guide and focus Navy aircrew coordination training research; (b) determination of instructional technology relevant to aircrew coordination training; (c) procedures and tools to assess and measure crew coordination; and (d) methods for performance assessment and evaluation in aircrew coordination training. These products will transition to the 6.3 Aircrew Coordination task, which is developing and validating proof-of-concept aircrew coordination training modules. Aircrew training is costly, but is not nearly so expensive as an absence of training or training that is inefficient. This task can introduce greater efficiency into the aircrew coordination performance area by determining: 1) the requirements of coordinated performance; 2) the obstacles to that performance that arise both from human factor design deficiencies and training needs; 3) diagnostic measures to determine specific training needs; 4) training methods that are designed to address specific problems; and 5) performance measures for aircrew coordination. The results can directly impact all multi-seat operational systems.

STATUS: Three scenarios for the full mission simulator have been developed for the CH53E community and twelve crews have been videotaped in these scenarios. An analysis of pre-flight brief behaviors as they relate to coordination behaviors has been conducted. Fourteen crews have "flown" both low fidelity and high fidelity scenarios and their reaction data indicate that they find the low fidelity scenarios appropriate and acceptable for ACT. Additional low fidelity research is being conducted in the training command, and a multi-trait, multi-method analysis to explore content validity of the identified ACT skills is being conducted. A questionnaire for crew ratings of coordination demand and workload requirements of various tasks has been completed for the CH46. This information can be used to develop equivalent scenarios for training and evaluation of ACT. The methodology for training communication and assertiveness has been explored and behavioral practice and feedback have been found to be the only effective method for both skills. An experiment on decision making strategy has been completed and demonstrates the advantage of the use of a top down decision making strategy. This information is being included in the decision making modules of the ACT program. An observer training course for ACT has been completed and pilot tested. The Naval Center for Applied Research in Artificial Intelligence has been working on developing an expert system to assist in this training, demonstrated their progress in FY91.

MAJOR MILESTONES:

Demonstration of Expert System
Report of Results/Recommendations
Transition to Advanced Development

FY91
FY92
FY94/FY95



RETENTION OF TRAINED SKILLS

Principal Investigator: G. Micheli

Code 26 Phone: 407/380-8282

DTIC Agency Accession Number: TBD

BACKGROUND: Even the most effective training program cannot ensure that trainees will be able to perform on the job if they do not retain the skills they have learned. This is especially problematic for perishable skills such as complex procedural tasks, tasks that are seldom practiced, or for reservists, who only train during brief and intermittent periods. Although considerable research has been conducted on skill retention, most training effectiveness evaluations are not able to longitudinally track trainees to determine how long and how well skills are retained after training. Additional information is needed on the effects of task parameters, amount and distribution of practice, use of training devices and simulators, instructional techniques, conditions of transfer, individual differences, and other variables on skill retention. Information is also needed to develop performance measures that can be used to predict operational performance.

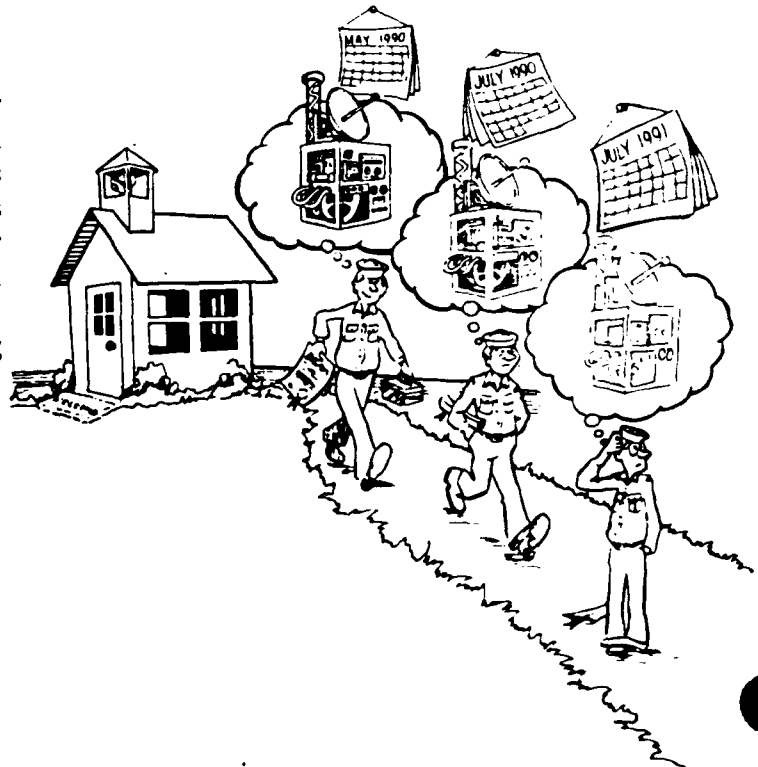
OBJECTIVE: To develop guidance for improved training device and training simulator design, more effective and efficient methods for use of these devices, and ways to improve performance measurement methods for use in predicting operational performance and to improve skill retention.

BENEFITS: Information on the variables affecting skill retention will help in the development of training devices, simulators, and instructional techniques, which can efficiently maximize the retention of critical skills. Such information, together with predictive performance measures, will also enable the Navy to target personnel who need refresher training to maintain criterion levels of operational readiness and will provide information on the design of refresher training. This retention of skills has been identified as a serious problem in the Navy and DoD (Schendel, Shields, Katz, 1978; Vineberg, 1975; Ellis, 1979; Hagman and Rose, 1983). However, there is currently a limited knowledge about the retention of skills (Hagman and Rose, 1983)

STATUS: This is a new start for FY92. In FY92, existing literature will be surveyed, resulting in a documented literature review which will examine the scope of the skill retention issue and high payoffs. A needs analysis will be conducted at select Navy sites in order to pinpoint types of skills that suffer most from retention effects. Finally, an experimental facility will be established, hypotheses will be generated, and pilot testing will begin.

MAJOR MILESTONES:

Establish Facility	FY92
Conduct Experiments	FY93
Technical Report	FY94



**EMBEDDED TRAINING TECHNOLOGY
IDENTIFICATION AND DEVELOPMENT**

Principal Investigator: R. Ahlers

Code 26 Phone: 407/380-8569

DTIC Agency Accession Number: DN708021

BACKGROUND: Shorebased trainers have limitations, among them: training sites often do not conform to any platform's unique configuration of equipment and software; there are a limited number of sites; trainers often simulate only a portion of the equipment normally found on-board, with reduced fidelity simulation of some elements; and personnel are removed from their normal duty station for extended periods of time. Planners have increasingly emphasized embedded or organic shipboard training systems as the method to overcome the limitations of shorebased training.

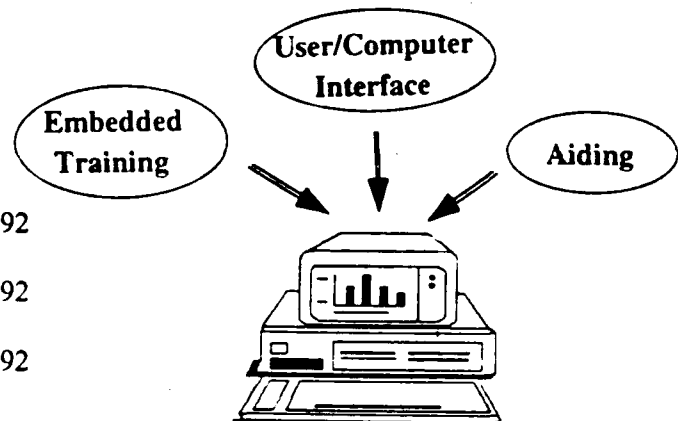
OBJECTIVE: To advance the understanding of requirements for embedded operator and tactical team training systems, and also suggest immediate improvements that can be incorporated into embedded training that is currently under development, evaluation, or already fielded.

BENEFITS: Embedded training (ET) will provide training in all warfare areas to individual operators, to tactical decision makers, to sub-teams and ultimately to full combat system teams operating in coordinated efforts in multi-threat warfare. State-of-the-art training technology will make ET programs true training systems. This effort will suggest immediate improvements that can be incorporated into currently fielded ET. Up to 80% of the cost of a training program is consumed by the delivery of instruction to trainees. These costs, which can exceed \$200K per course for each student, can be reduced by improving the efficiency and effectiveness of the training. This can be realized by improving the instructional elements of training systems, by applying technology such as that developed in this task.

STATUS: The technique for cognitively structuring lessons was experimentally evaluated at the Fleet Combat Training Center, San Diego. A report is in preparation. A cognitive model which integrates decision aiding and ET was formulated. It will form the basis for an integrated methodology. Overall design for the intelligent platform authoring and runtime environment was begun, and several supporting components are nearing completion. SubScript, was installed for long-term evaluation at the Submarine Training Facility in Norfolk. Initial design of on-line assistance for ET operators has been completed. This work included the design of an experiment to define optimum information structuring strategies for on-line assistance.

MAJOR MILESTONES:

Technical Report, Evaluation of Cognitive Structured Lessons	FY92
Technical Report, Embedded Instructor Training in Trainer Operator Consoles	FY92
Demonstration, Intelligent Platform and Runtime System	FY92



AIRCREW INSTRUCTIONAL SYSTEM (AIS)

Principal Investigator - D. Fowlkes

Code 26 Phone: 407/380-4789

DTIC Agency Accession Number: DN709008

BACKGROUND: The Navy, Air Force and Air National Guard Tactical Aircrew Combat Training System (TACTS)/Aircrew Combat Maneuvering Instrumentation (ACMI) is a telemetry based system at which pilots employ operational aircraft to practice air-to-air, strike, and electronic warfare engagements. Virtually all critical aspects of engagements are recorded for debriefs of aircrews following each exercise. Currently, debriefs of TACTS exercises can only be conducted using the \$1M Display and Debrief Subsystem (DDS). The high price of the debrief facility limits the number of aircrews receiving debriefs. The goal of this task is to demonstrate a low-cost, personal, computer-based debrief capability that allows aircrews to receive meaningful debriefs in a timely manner.

OBJECTIVE: The objective is to demonstrate the capability to conduct meaningful and timely debriefs of TACTS/ACMI exercises using a personal computer-based system. This capability will then be adapted to provide trainee performance feedback with flight simulators.

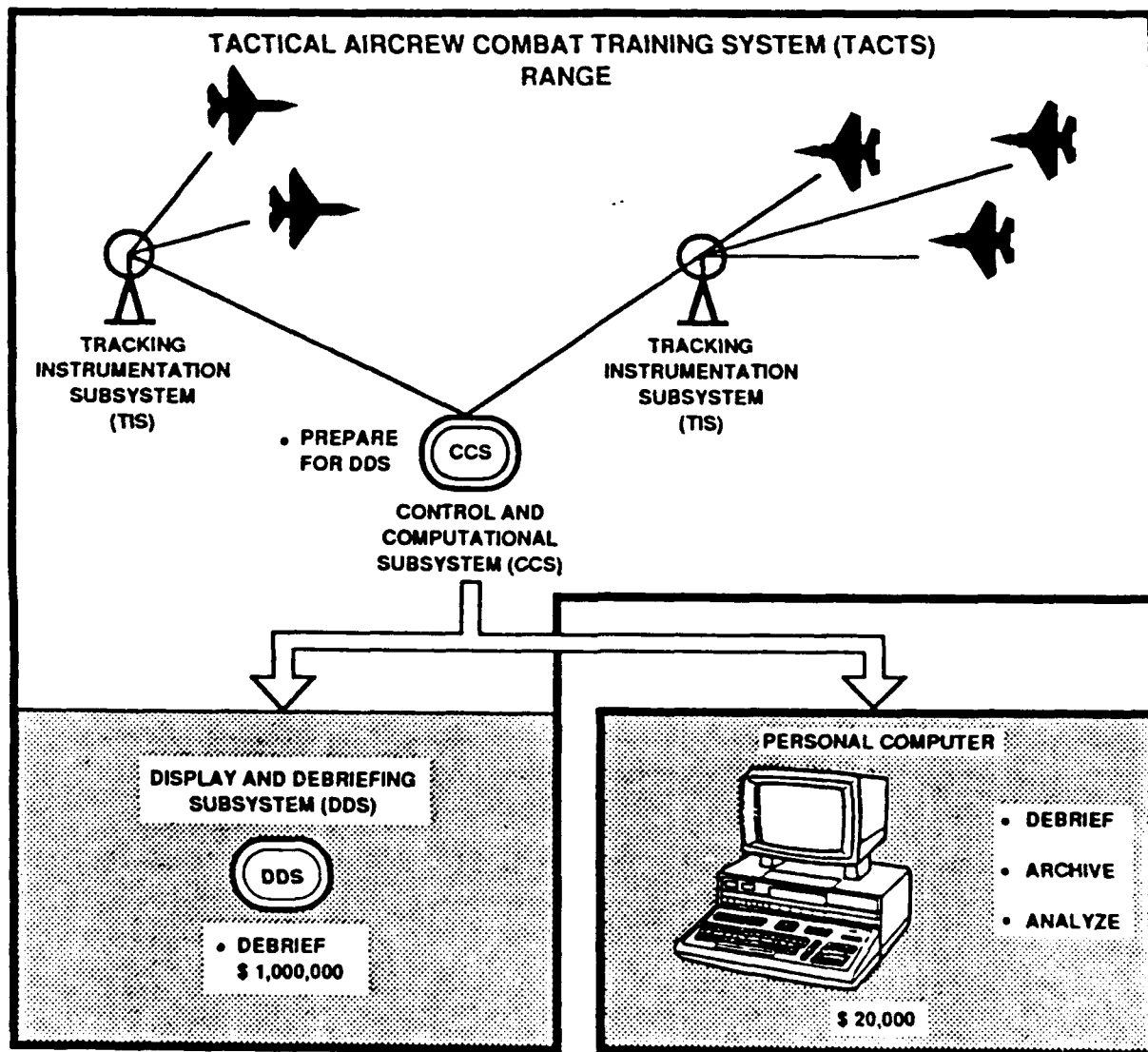
BENEFITS: Expected payoffs include the capability to utilize a low cost system to conduct meaningful and timely debriefs of TACTS/ACMI exercises and the development of specifications for debrief facilities used by aircrews.

STATUS: Debriefs of the exercises are currently conducted on the DDS. While the DDS has proven to be an invaluable training tool, a smaller and less expensive debrief system is required - the Mini-Display and Debrief System (M-DDS). Achievements from this task include the demonstration of an experimental M-DDS. The M-DDS is hosted on commercially available hardware, and the software is written in higher order language. The M-DDS allows timely debriefs, is easy to use, provides graphics and alphanumerics on two CRTs, and includes synchronized voice playback. The M-DDS is currently being evaluated at the Gulfport ACMI by the Air National Guard.

The capabilities developed under AIS have evoked high interest, and briefings and demonstrations have been requested and given to Navy (Air-423), Air Force (Eglin AFB), and Air National Guard (National Guard Bureau) activities responsible for TACTS/ACMI.

MAJOR MILESTONES:

Demonstration of M-DDS to Air National Guard ACMI Ranges	FY91
Demonstration of, and Specifications for, a Low-Cost Debrief Capability for Use by the Joint Service TACTS/ACMI Community	FY92



SIMULATION OF ADVANCED SENSORS.

Principal Investigator - J. Allen

Code 25 Phone: 407/380-4579

DTIC Agency Accession Number: DN708025

BACKGROUND: The advanced development and increased use of such sophisticated sensors as thermal imaging and imaging radar have significantly expanded the capabilities of military platforms. Sensor technology developments have contributed both to safer and more effective operations and tactics. These gains in capability, however, can only be realized fully through effective training programs. One of the challenges facing simulation today is the creation of cost effective simulations of advanced sensor systems for training high data rate/workload conditions found in both aircraft and shipboard operation. Current personal computer technology offers the potential for providing a low cost surface navigation training aid if appropriate radar and other electronic navigation aids can be simulated. Traditionally, radar simulation requires special hardware (target generators, etc.) which may not be required to teach rudimentary skills or demonstrate basic navigation concepts. Research will demonstrate a low cost personal computer based interactive surface navigation training aid that significantly augments traditional classroom and high fidelity simulator based training.

OBJECTIVE: To improve surface navigation training by developing appropriate PC based simulations of radar and other electronic navigation aids.


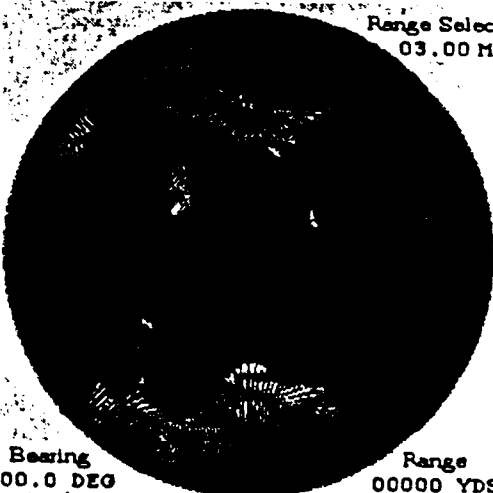
BENEFITS: This task will provide design approaches and laboratory demonstrations of PC based radar and other electronic navigation aids simulations. Introduction of this new technology into classrooms will provide instructors with a new classroom tool which can be used to illustrate and dramatize fundamental surface navigation concepts. By providing a presentation tool for the instructor and a visual focal point for students, abstract concepts can begin to take on more meaning and navigation procedures learned as a series of discrete steps become more intuitive. Theoretically, any world-wide coastal area supported by Defense Mapping Agency (DMA) data in CD ROM format will be available for simulation. Semi-automated, area-specific data base generation techniques will provide quick turn-around methods of database generation. On board ship, less experienced members of the navigation team may benefit from its use as a concept review tool. A more robust version might be used for harbor familiarization.

STATUS: Radar simulation algorithms have been developed which show promise for PC-based radar simulation. In theory, a PC system costing \$1,500 could generate both the database and a real-time or near real-time simulation of a surface navigation radar display for any area of the world covered by DMA data. In FY91, the major task involved the production of an adequate simulated radar landmass presentation. A preliminary feasibility model is located at Quartermaster "A" School, Service School Command, Orlando and is currently being used to test concepts and algorithms. The accompanying figure depicts the present user interface. A DMA derived database is displayed on the left with a representation of a real-beam radar display at a user determined location within the displayed database to the right.

MAJOR MILESTONES:

Installation of Preliminary Model at QM "A" School	FY91
Prelim Feasibility Model Demo at I/ITSC	FY92
Feasibility Model Complete	FY93
Technology Transition and Final Report	FY94

Ownship Data		Radar View	
Course	270.0 ▲	Chart	
Speed	10.0 ▼	PPI	
Latitude		Cancel	
Longitude		Exit	

	
	Range Select 03.00 MI
Bearing 000.0 DEG	Range 00000 YDS

CIG COST/PERFORMANCE ENHANCEMENT

Principal Investigator - J. Booker

Code 25 Phone: 407/249-3122

DTIC Agency Accession Number: DN708026

BACKGROUND: Weapon system trainer cost is rapidly approaching the cost of the platforms which they represent. Aircraft trainer systems have recently been incurring costs for the visual simulation system in the range of one-third of the total system costs. The technical problem is to develop techniques which will reduce the cost of Computer Image Generation (CIG) visual simulation systems while maintaining or improving performance.

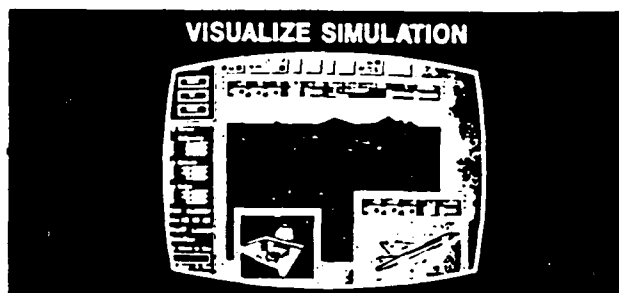
OBJECTIVE: The objective is to reduce the cost of CIG visual simulation systems while maintaining or improving performance. Demonstrations of utilization of low cost workstation CIG systems will establish a trend of cost reductions in high end, high performance CIG systems.

BENEFITS: This effort will develop and demonstrate techniques which will reduce cost and improve performance of CIG visual simulation systems in future training devices. Both low cost workstation technology hardware and interactive database development software techniques will be explored to provide low cost options. Currently, CIG system hardware costs are running \$1M to \$2M per channel for training simulator systems. New graphics workstation technology-based systems should cost under \$100K per channel.

STATUS: Low Cost CIG Workstation Technology results from this R&D task were used as basis for Visual System specification for the Barge Ferry Pilot/Coxswain Trainer. SBIR Phase II Contract with MANDEX for 3-D Data Acquisition Techniques was completed with delivery of the Final Report and Acquisition System User's Guide. A trend toward reduced cost CIG hardware appears to have been established with recent announcements by industry of new products reflecting low costs by high end producers and increasing performance by low cost CIG workstation producers.

MAJOR MILESTONES:

Paper published at the Image FY92
Society IMAGE VI Conference



**PROGRAMMER PRODUCTIVITY
AUTOMATED DATA BASE
DEVELOPMENT SOFTWARE**



**LOW COST CIG
WORKSTATION
TECHNOLOGY**

SYNTHESIS OF ACTIVE ACOUSTIC SIGNALS
AND DISPLAYS FOR TRAINING

Principal Investigator - L. Healy

Code 25 Phone: 407/380-4590

DTIC Agency Accession Number: DN700011

BACKGROUND: This task addresses two separate problems in the use of active sonar: active sonar used for ASW and active sonar used for mine detection. The major problem in each of the areas is target recognition. In ASW, the operator must distinguish a real submarine from sea mounts, schools of fish, or other false targets. In mine countermeasures, the operator must detect a mine in the presence of clutter or other objects. In either case, the Navy has an urgent need for both basic and refresher operator training in the effective use of the active sonar and the recognition of the submarine or mine in a background that provides many false targets. Mine detection requires targets of sufficient fidelity to allow classification of an object as a mine or non-mine and even the determination of the type of mine. The key element in providing operator training is the generation of realistic displays that provide appropriate representation of the tactical situation and the effect of actions taken by the sonar operator or by the tactical team. The availability of microcomputers provides a means of implementing low-cost operator trainers for both the mine detection and the ASW problem.

OBJECTIVE: The objective of this task is to address the synthesis of high-fidelity active sonar displays for use in tactics training within the limits of microcomputers.

BENEFITS: Benefits from this research will include: (1) significant reduction in training systems cost (both initial acquisition cost and life cycle cost); (2) ability to use standard Navy desktop computers to provide active sonar operator training; and (3) techniques and data bases which can be incorporated into larger and more complex training systems.

STATUS: Mathematical models for the AN/SQS-53A sonar display and audio were developed. These models are based upon recorded sonar data. The models were implemented using a MicroVAX workstation with special audio circuitry. This allows sound synthesis by providing a sampled representation of the aural data. A simple mine model was developed using a spherical-shaped mine and a three-layered ocean.

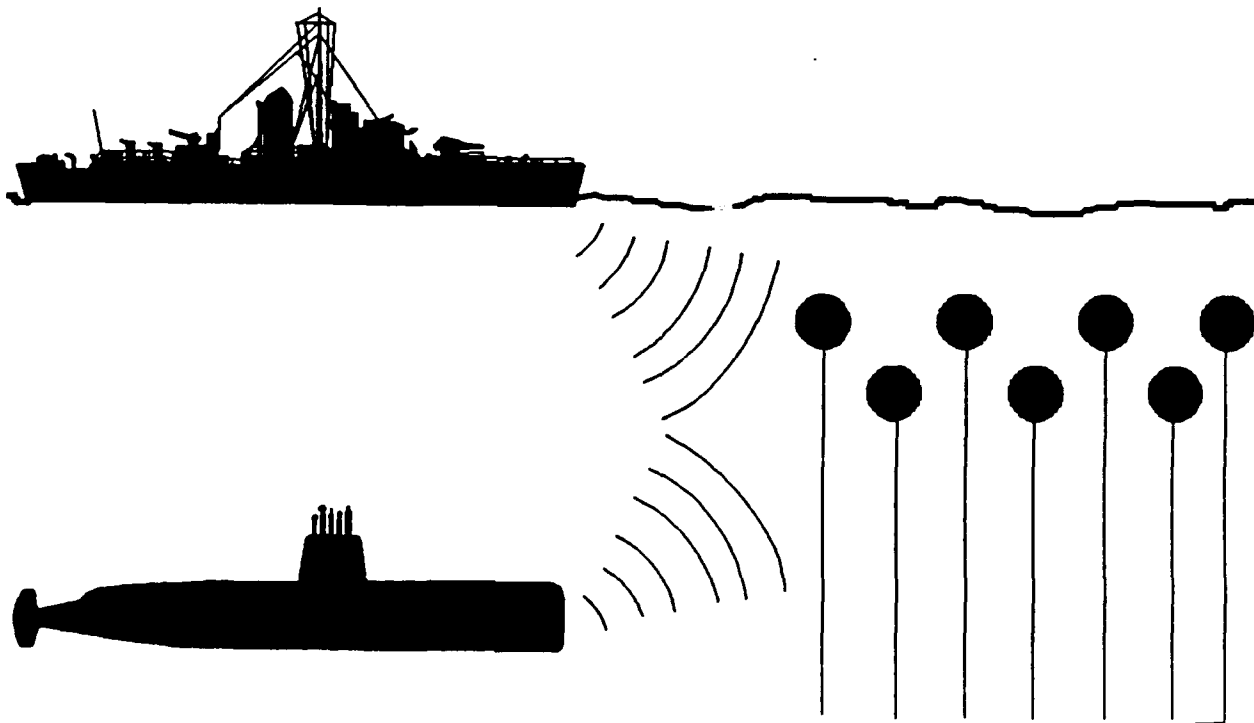
Recent research in generation of high-fidelity acoustic displays for training has concentrated on the use of actual acoustic contacts to provide the realism needed for classification of active sonar contracts as target or nontarget. That research, using actual acoustic contacts, has transitioned to PE0603733N to support the development of a demonstration of active sonar training capability using the present Surface Ship Passive Acoustic Analysis Trainers. In addition, this same research has provided two critical elements essential to the synthesis task: (1) key research personnel who are experienced in active sonar and in sonar signal processing, and (2) a data base of actual acoustic contacts to serve as both a source and a control in the development of synthesis techniques.

MAJOR MILESTONES:

Progress Reports: Submarine Target Synthesis	FY92
for AN/SQS-53A	
Spherical Mine Model and	FY92
Ocean Model for Subsurface	

	Improved Mine Models for Surface and Subsurface	FY93
	Dynamic Displays for Surface and Subsurface Mine Avoidance	FY94
Demonstrations:	Target Audio and Video for AN/SQS-53A	FY91
	Static Mine Avoidance Displays for Surface and Subsurface	FY92
	Dynamic Mine Avoidance Displays for Surface and Subsurface	FY93
	BSY-2 Console Simulation	FY94
	SQQ-30 Console Demonstration	FY95

MINE AVOIDANCE



MOVING WEAPONS SIMULATION TECHNOLOGY

Principal Investigator - A. Marshall

Code 25 Phone: 407/380-4653

DTIC Agency Accession Number: TBD

BACKGROUND: Technology currently available to provide simulator environments that allows machine gun training from moving vehicles and aircraft without live rounds or firing ranges is insufficient. The technical problems are: development of a low-cost miniature motion platform to support the gunner and the weapon; development of the equations of motion; development of a means of simulating tracers and explosions; development of more accurate means of determining weapon aiming position.

OBJECTIVE: The objectives are to develop technology to simulate tracers and explosions that have a 3-D appearance to the trainee; develop the technology to more accurately determine weapon pointing location required by the very accurate 50-cal machine gun; develop the technology for low-cost/small motion platforms; determine the training effectiveness of the simulator and the efficacy of the motion platform; develop the ballistic equations for moving platforms; and to develop a research model.

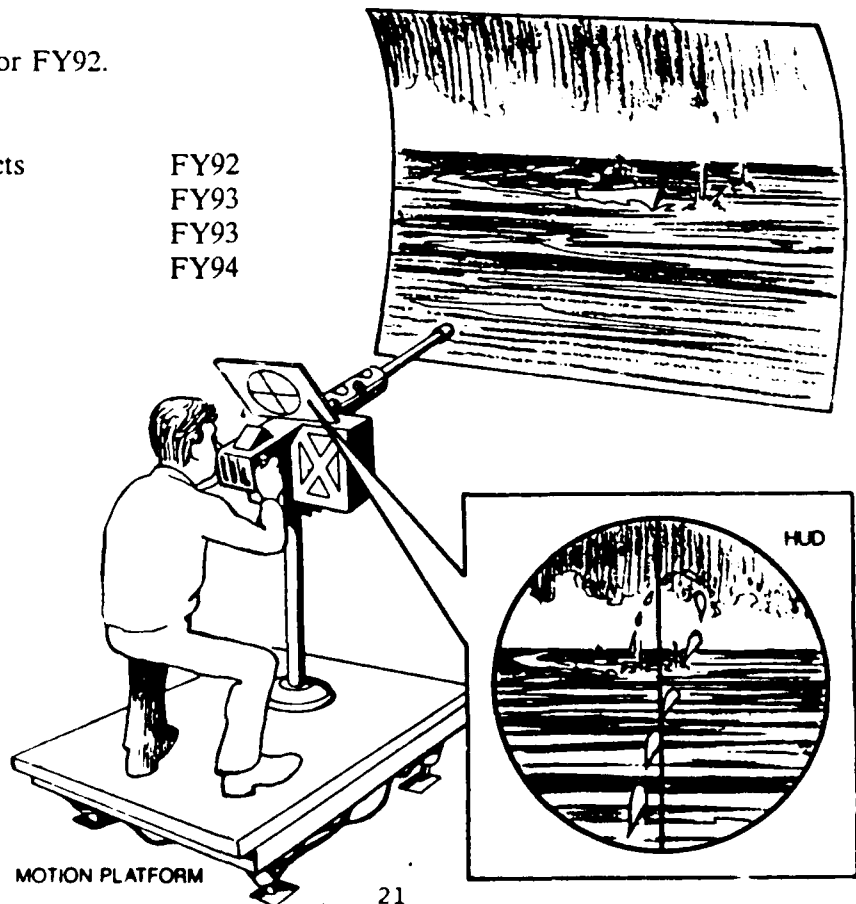
BENEFITS: This technology will be used to develop trainers to teach gunners to fire machine guns from the following moving platforms: Riverine Water Craft Humvee, Dune Buggies, etc., and Helicopter Door Gunnery Trainers. The trainers will negate the use of real vehicles which will save money on fuel and wear and tear on helicopters and land vehicles. Special firing ranges will no longer be required. In many locations and countries the firing of live machine gun rounds is not permitted. The trainers will be able to more accurately score and determine why a trainee is missing the target.

STATUS: This is a new start for FY92.

MAJOR MILESTONES:

3-D Tracer and Explosion Effects
Motion Platform Completed
Fabricate Research Model
Report

FY92
FY93
FY93
FY94



CRYSTAL TARGET PROJECTOR
Principal Investigator - R. Hebb
Code 25 Phone: 407/380-4578
DTIC Agency Accession Number: DN709009

BACKGROUND: A low cost, high resolution and brightness color projector is needed for visual simulation systems such as flight simulators, air traffic control trainers, ship docking trainers, helmet mounted displays and night vision goggle simulation. Presently only high cost light valve projectors can provide reasonably adequate resolution and brightness. Recent significant advances in CRT faceplate technology provide the opportunity to develop a low cost, high resolution/brightness projector.

OBJECTIVE: The objective of this task is to develop and test a color video projector using single crystal faceplate technology. Theory indicates that the development is feasible.

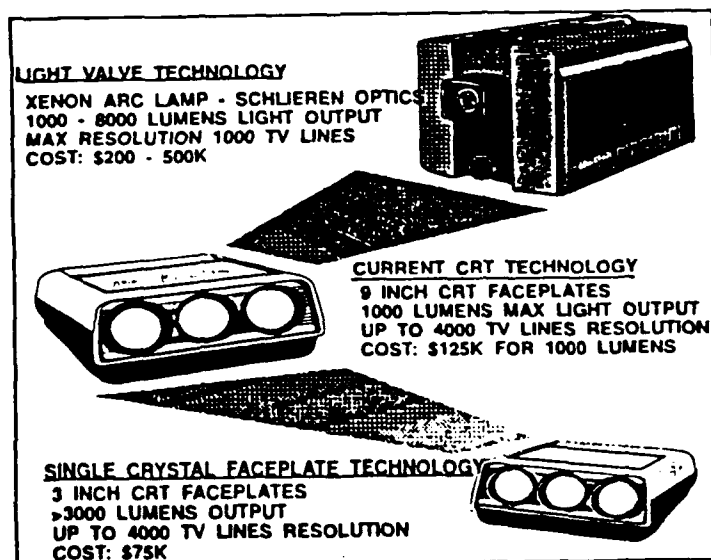
BENEFITS: Development of this new state-of-the-art projector will provide better image brightness and resolution than currently available for a cost savings of about \$200K per channel, and will allow a smaller projector footprint.

STATUS: External light output from single crystal phosphors has been increased by forming a pyramidal facet structure on the epitaxial phosphor layer grown on the single crystal CRT faceplate. This pyramidal structure, which re-directs otherwise lost light, was formed by the photolithographic application of a hexagonal masking layer with subsequent acid etching to form facets in the crystal phosphor. Several sets of Ce:YAG single crystal phosphor faceplates to be used in the construction of evaluation CRTs have been delivered.

Under a contract for the design and construction of a high performance video projection brassboard, two 2-inch faceplates have been integrated into suitable CRT envelopes for evaluation of the single crystal faceplates. Other progress to date includes the completion of the video brassboard and the testing of the two single crystal CRTs with 2-inch faceplates. A peak faceplate brightness of 62,700 FootLamberts was recorded, with a net light output of 435 Lumens per Watt, point to the achievement of a 2000 Lumen output goal from a 2.75 inch diagonal raster on a 3-inch Ce:YAG faceplate.

MAJOR MILESTONES:

Testing of 3-inch diagonal Ce:YAG Single Crystal Faceplates	FY92
Testing of Ce:BEL and (Ce,Gd): YAG Single Crystal Faceplates	FY92
Demonstration of Projector Brassboard in a Dome Screen	FY92
Delivery of Brassboard	FY92



TACTICAL TRAINING INSTRUCTOR COMPONENTS (TACTICS)

Principal Investigator - B. Pemberton

Code 25 Phone: 407/380-4602

DTIC Agency Accession Number: DN700009

BACKGROUND: New concepts are required for effective utilization of tactical training systems of the 90s. A ten-fold increase in the total number of tracks currently simulated for tactical training systems is a requirement. However, no corresponding increase in the number of training system instructors to generate or control training system scenarios using this increased number of tracks is anticipated. The TACTICS task is investigating two new concepts to meet the increasing demand on tactical training system instructors: automatic scenario generation, and automatic scenario control.

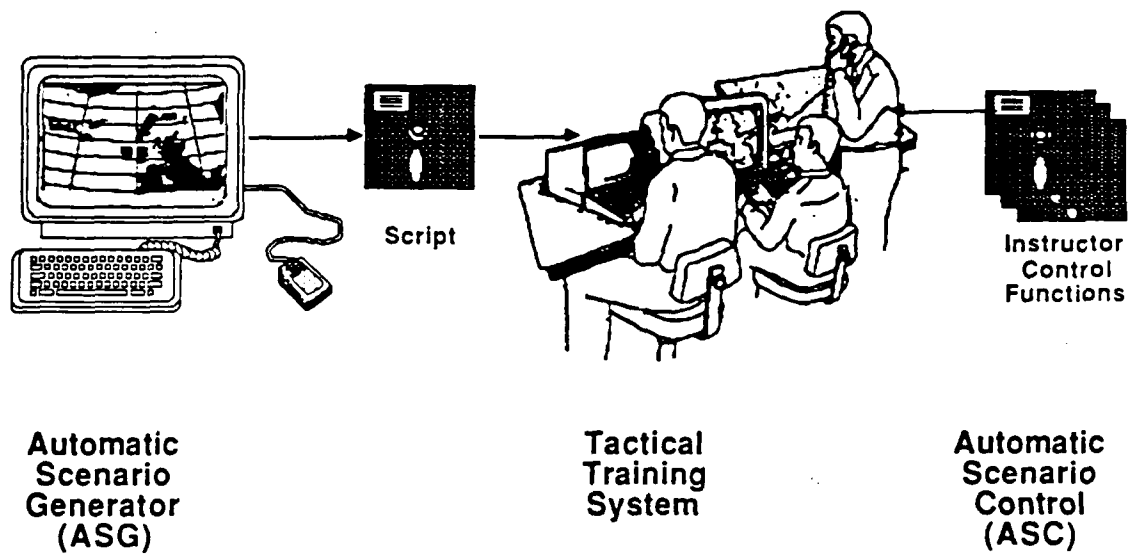
OBJECTIVE: The objective of TACTICS is to investigate two concepts and develop two demonstration systems -- 1) Automatic Scenario Generator (ASG), and 2) Automatic Scenario Control (ASC). The ASG objectives are to reduce instructor's time and effort for scenario setup, and make the user-machine interface easy to use. The objectives of the ASC are to reduce instructor workload, allow instructor to monitor more information, and provide real-time performance measurement and feedback.

BENEFITS: Fleet readiness and mission effectiveness will be enhanced with the automation of the instructor training system functions. Results of this research will provide rapid development and operation of training system exercises that are representative of operational events. The time required to create a typical scenario will be reduced from 6 weeks to 1 week. The amount of information required to specify a scenario will be reduced by over 90%. During control of scenarios, instructors will be provided multiple windows to increase the amount of information monitored, automatic warfare advisors to increase instructor response to rapidly changing tactical situations, and automatic performance measurement and feedback to provide timely evaluations of exercise successes.

STATUS: Significant accomplishments for the TACTICS task for FY91 include: (1) contract for TACTICS ASG completed: Critical Task Analysis Report, System Specification, Scenario Generation Expert System (SAGES) demonstration system, and Final Report successfully delivered, (2) TACTICS concept paper presented at the 12th Interservice/Industry Training Systems Conference (I/ITSC), (3) ASG demonstration software successfully ported and operational on a Sun Workstation for future incorporation into embedded training applications, (4) NPRDC's Batman and Robin software in process of evaluation for use with ASG, (5) NRL's intelligent platform software in process of evaluation for application to ASC, and (6) HARPOON battle force wargame and HARPOON Scenario Editor investigated for applicability to TACTICS.

MAJOR MILESTONES:

First ASG Demonstration System SAGES	FY91
Delivered	
Demonstration System Rehosted to Sun	FY91
Workstation	
Enhancements of ASG	FY92
Demonstration of Automatic	FY93
Situation Assessment Model	
for AEGIS and/or Organic Combat	
Systems Training Technology	



**Tactical Training Instructor Components for the '90s --
Automatic Scenario Generator and Automatic Scenario Control**

ADVANCED COMPUTING APPLICATIONS

Principal Investigator - R. Soeldner

Code 25 Phone: 407/380-8202

DTIC Agency Accession Number: TBD

BACKGROUND: There is a continuing need for high performance, low-cost computing for simulation in general, and training devices in particular. Some of the current problems which could be resolved with high performance computing are data visualization for instructor and students, complex battle force simulations, intelligent computer-directed adversaries, simulation of missing combat team members, intelligent computer-based tutoring, and many forms of animated displays. On the other hand there are a number of high performance computing elements, such as math coprocessors, digital signal processors, array processors, superscalar and pipeline architecture processors, graphics processors, and a myriad of parallel processors available on the open market which could be directly applied to these problems. For instance, the addition of a math coprocessor to a personal computer significantly increases the performance of the computer when used to solve scientific problems. Despite this, there has been little use of these computer technologies in resolving computer simulation problems. The reason for this seems to be the specialized programming required to effectively use these devices and the lack of library software directed toward simulation.

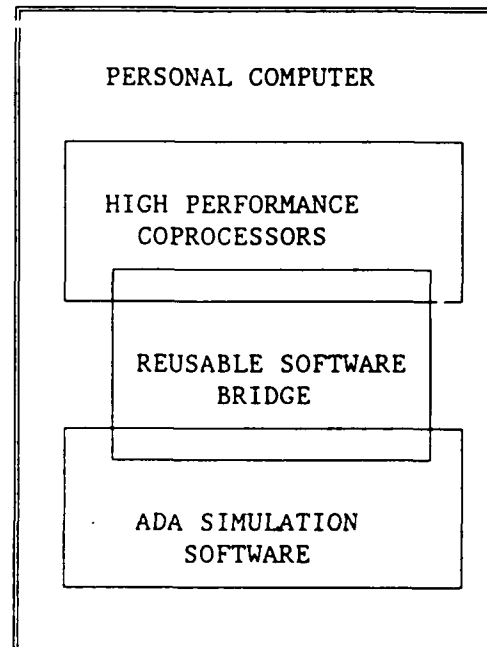
OBJECTIVE: The purpose of this task is to explore the possibility of extending the math coprocessor concept to the use of other high performance processors in the solution of simulation problems, by embedding highly iterative algorithms in the coprocessors and isolating implementation detail through the use of reusable Ada specifications.

BENEFITS: If this task can successfully demonstrate the feasibility of this concept, it could open the door to many low-cost computer simulation applications considered to be impractical because of computer run times. This task coupled with the Reusable Ada Repository for simulation, currently under development for NAVTRASYSCEN, will provide a vehicle for widespread use of the products of this and follow-on efforts.

STATUS: This is a new start for FY92.

MAJOR MILESTONES:

Initial Performance Experiments	FY93
A practical simulation problem involving ocean acoustics and requiring high performance computing will be implemented	FY93
Demonstration involving the data visualization of multidimensional ocean acoustic data	FY94



VIRTUAL ENVIRONMENT TRAINING TECHNOLOGY

Principal Investigator - D. Fowlkes

Code 26 Phone: 407/380-4789

DTIC Agency Accession Number: TBD

BACKGROUND: Virtual Environment (VE) technology is a newly coined term which encompasses a number of display and transducer technologies designed to make human-computer interfaces more efficient and effective. VE technology differs from conventional training simulator technology in that the human computer interface in a simulator is hardware specific to the real world equipment being simulated. Whereas, the interface in a VE system is designed to be specific to the human user's needs for sensory inputs and control outputs with little or no hardware specific to real world equipment. Ultimately, a single VE interface could provide a user with any training environment for any piece of operational equipment. The VE interfaces the trainee user with a training system using displays and transducers. Displays provide information to the user from the training system computer while the transducers relay information from the user to the training system computer. Displays for VE which currently are being developed for VE applications include visual, audio, tactile, and force. Transducers include position, orientation, speech, and force.

OBJECTIVE: This project will analyze and demonstrate the feasibility of using VE technology to improve the efficiency and effectiveness of military training. VE will be evaluated as a training delivery medium; as a replacement for current training media; as an enhancement to current training media; and as an enabling technology capable of providing training in areas where existing training media are inadequate.

BENEFITS: The utilization of VE in military training applications is expected to be an evolutionary process. Existing VE technology is relatively crude and may have limited cost and training effectiveness benefits. Initially, this project will identify the types of training which will benefit from VE technology at its current level of development and provide design guidelines for advanced development for specific training applications. Experience gained from the initial investigations will result in the specification of performance characteristics and features of display and transducer components which will allow application to additional training areas. As these component performance capabilities are developed, additional training areas will be addressed and transitioned.

STATUS: During FY91, VE technology was surveyed to determine the current VE technology performance capabilities. Several training applications were identified and a development plan prepared. The planned technical approach involves selecting specific skills which are currently the objective of an existing training system; designing, developing, and fabricating a VE experimental system using available VE displays and transducers; evaluating the capability of a user to perform the specific skill in the VE; developing or modifying an existing instructional system to use the VE delivery system; evaluating the potential training and cost effectiveness of the VE-based training system for the specific training application; and generalizing the results to similar training applications. Throughout the process, deficiencies in the VE training approach will be classified as either deficiencies in the VE interface components or deficiencies in the capability of the training system to utilize the VE.

MAJOR MILESTONES:

Demonstration of VE air-to-air combat debrief/replay	FY92
Evaluation of VE air-to-air training application	FY92

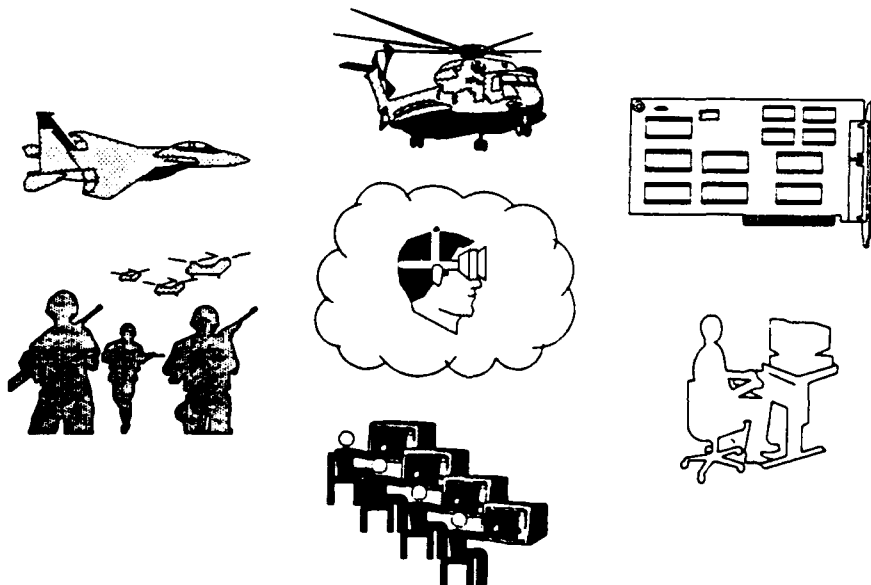
Demonstration & evaluation of VE
control panel operation
Demonstration & evaluation of VE
stick/throttle operation
Demonstration & evaluation of VE
tutor/instructor

FY93

FY94/FY95

FY96/FY97

VIRTUAL ENVIRONMENT TRAINING



TACTICAL DECISION-MAKING UNDER STRESS

Principal Investigators - E. Salas/J. Cannon-Bowers

Code 26 Phone: 407/380-4651

DTIC Agency Accession Number: TBD

BACKGROUND: As a result of recent combat events, a fundamental reassessment of requirements for a wide range of Navy systems is taking place. Emphasis is now beginning to shift to the problems of dealing with low- and mid- intensity conflicts where events fit multiple possible hypotheses with respect to contact identification, intent, available responses and their consequences. At present, state-of-the art, real-time battle management systems are based on doctrine that is well-suited to problems that might be encountered in all-out war, but may not be optimum for the problems inherent in less than full-scale warfare. Recent events, such as the one involving the USS Stark, where the decision not to initiate countermeasures was the incorrect one, and the USS Vincennes, where the opposite decision was the incorrect one, have focussed attention on the human factor in decision-making under low- and mid- intensity conflict. The catastrophic costs of these decisions dictate that improved support must be provided to the tactical decision-maker in these unexpected, highly charged, extremely short-duration, confusing situations where it is not clear who the enemy is, let alone what he intends to do.

OBJECTIVE: The objective of the TADMUS project is to apply recent developments in decision theory, individual and team training, and information display to the problem of enhancing tactical decision quality under conditions of stress. This will be accomplished by a cooperative program in human factors and training involving the Naval Ocean Systems Center and NAVTRASYSCEN as well as Navy, industrial, and academic organizations. The technology will be demonstrated and evaluated in the context of anti-air scenarios.

BENEFITS: The results of this effort will be an enhanced understanding of human decision-making processes and a set of training and simulation principles that will lead to improved individual and team tactical decision-making under conditions encountered in low-intensity conflict situations.

STATUS: Fleet contacts were expanded with multiple visits to: Aegis Training Center, Dahlgren, VA; CSEDS (Combat System Engineering Development Site and Aegis Training Facility), Moorestown, NJ; Fleet Training Unit, Mayport, FL; and Little Creek, VA; COMTRALANT; COMNAVSURPAC; and several Aegis class cruisers. These visits and interviews have been very productive in identifying tactical tasks and operational scenarios for laboratory investigation. They have resulted in strong operational endorsements of the project and have made important contributions to the development of models of decision-making strategies.

The laboratory simulation testbed, called Decision Making Evaluation Facility for Tactical Teams (DEFTT), has been installed at NAVTRASYSCEN and NOSC. DEFTT simulates shipboard AAW scenarios and consists of networked workstations for the CO, TAO, AAWC, TIC, IDS, and EWS.

Several performance measures and scales (e.g. descriptive, diagnostic, process and outcome measures) for tactical teams were defined and formulated with guidance from TACTRAGRUPAC and Fleet Training Unit, Mayport.

Progress has been made in defining and selecting task-related and environmental stressors for experimental manipulation. An innovative matrix has been formulated that highlights relationships between training strategies and training content areas.

MAJOR MILESTONES: Products of this effort will include:

- | | |
|---|------|
| A definition and description of the specific decision-making tasks that will be the object of decision support and training interventions to be developed in later in the program | FY92 |
| An understanding of why and how decisions are made in targeted tasks, and identification of decision biases exhibited in these tasks | FY92 |
| Laboratory facilities, providing a realistic experimental environment | FY92 |
| A strong measurement capability to assess tactical decision-making by individuals and teams | FY93 |
| A baseline of decision-making performance under varying levels of stress | FY93 |

**AEGIS DISPLAY SYSTEM
CONSOLE OPERATORS**



**INDEPENDENT RESEARCH (PROGRAM ELEMENT 0601152N)
and INDEPENDENT EXPLORATORY DEVELOPMENT
(PROGRAM ELEMENT 0602936N)**

Independent Research (IR) and Independent Exploratory Development (IED) Programs provide discretionary funds for basic research and exploratory development to the technical directors of the ten participating Navy laboratories and centers, and the Naval Medical Research and Development Command. The programs provide an opportunity for Navy scientists and engineers to pursue new and innovative research and technology areas for the solution of Navy and Marine Corps problems. This presents several advantages.

Scientists and engineers conduct self-initiated research and exploratory development with emphasis on simulation and training device technologies. This can involve efforts on more speculative approaches that are too risky for funding by existing programs.

Scientists and engineers build in-house expertise in areas of future importance. These skills enhance the "smart-buyer" capability of the Center and provide necessary technical skills to assess development and acceptance of innovative trainers.

The Navy knowledge base and technology base in Simulation and Training Device technology expands. There is no other Navy organization charged with, or capable of, the breadth and depth of the mission of multi-platform, joint service training system research, development, acquisition, and logistical support.

Many ancillary benefits enhance the Navy's strength in Simulation and Training Device technology procurement. Some of them are: the shortening of the time scale of programs; the solving of road block problems which cause delays in programs; a means of rewarding high quality ideas; extending research support for creative scientists and engineers; and providing a stimulating atmosphere conducive to generating new concepts and challenging ideas.

Descriptions of the FY 91 and FY92 IR and IED tasks follow.

TRAINABILITY FACTORS IN TRAINING EFFECTIVENESS

Principal Investigator - J. Cannon-Bowers

Code 26 Phone: 407/380-4830

DTIC Agency Accession Number: DN709002

BACKGROUND: There is little doubt that Fleet readiness, safety and performance depend largely upon the extent to which training systems impart critical knowledge and skills. Fiscal constraints demand further that military training resources are allocated carefully and exploited fully; a demand that is becoming more acute as a result of recent events. It is generally agreed, therefore, that attention must be directed toward understanding factors that contribute to the effectiveness of training programs and that result in the highest payoff in terms of operational performance improvement.

Research into training system effectiveness has most often assumed that the success of training is contingent upon variables such as instructional approach, training media, device fidelity, course duration, diagnostic feedback, and the like. While these "technical" factors are critical, there are a number of other factors that can have an impact on training outcomes. However, relatively little attention has been directed toward "nontechnical" variables that affect training effectiveness, such as factors that a trainee brings into a training program or factors associated with the operational context in which training occurs. The concept of "trainability" refers to the degree to which a trainee is able to acquire and maintain targeted skills, and subsequently apply those skills in the operational environment.

OBJECTIVES: The objectives of this research were: 1) to develop a comprehensive model of training system effectiveness that will provide a framework in which to investigate the impact of trainability factors, 2) to empirically determine how, and to what extent, trainability factors affect training outcomes in a military environment, and 3) to begin to derive recommendations for incorporating knowledge about trainability factors into the design of training systems as a means to enhance training effectiveness.

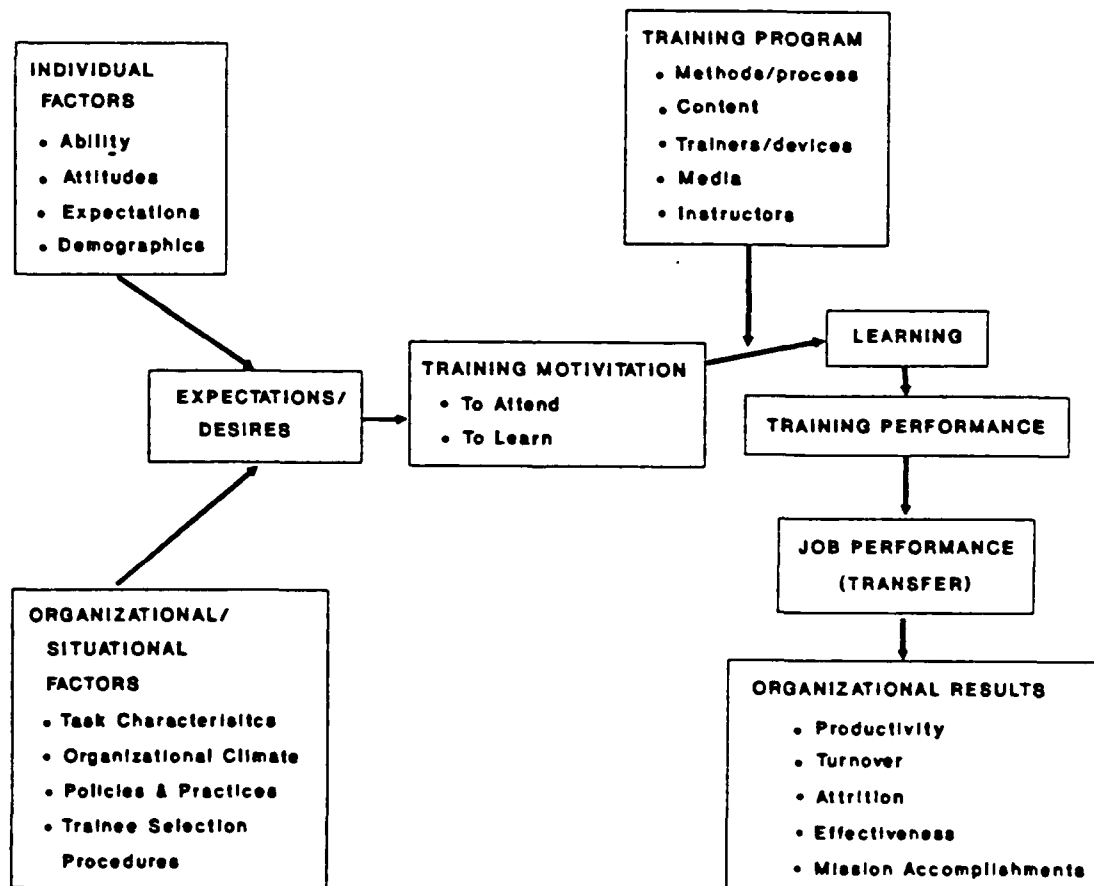
BENEFITS: The payoff of this effort will be a set of recommendations and guidelines for training system design that will increase the likelihood of effectiveness.

STATUS: This IR task was funded for three years and was completed in FY91. A theoretical model of the manner in which trainability factors affect training motivation and outcomes was generated. Once the model of training effectiveness was developed, it was used to generate hypotheses regarding the impact of trainability factors on selected training outcomes. Selected relationships in the model were tested for statistical significance using a series of hierarchical multiple regression equations. Overall, results of this investigation offered support for the notion that non-technical trainability factors are important to consider in training system design. Trainee self-esteem, pre-training expectations and pre-training motivation all had a significant impact on training performance indices. Testing of the model of training effectiveness in a second training environment was initiated. The goal was to extend and refine findings from the first data collection effort in a skills-training environment. This transitioned to the 6.2 Tactical Decision-Making Under Stress project.

Results of this research imply that no matter how well a training system is designed, it may not be maximally effective due to incompatibility with trainee attitudes, low trainee motivation, or

detrimental organizational conditions. Specifically it has been shown that: 1) trainability factors can be operationalized and measured reliably in a military environment, and 2) trainability factors have a significant impact on training outcomes. Products of this work include:

- 1) Enhanced understanding of trainability factors that affect various training outcomes
- 2) Prescriptions for system designers and instructional developers that will allow for enhanced training system design
- 3) Recommendations for re-design of existing training systems at minimal cost.



MODEL OF TRAINABILITY FACTORS AND TRAINING OUTCOMES

TACTICAL BEHAVIOR MODELING USING NEURAL NETWORKS

Principal Investigator - R. Ahlers

Code 26 Phone: 407/380-8569

DTIC Agency Accession Number: DN700006

BACKGROUND: Neural network technology represents a modeling technique which offers unique advantages to selected simulation applications. Certain enhancements to simulator-based training, such as student modeling and other-player simulation (e.g., tactical adversaries or missing team members) have not yet been reduced to practice despite focused research and development efforts. The difficulty of applying existing simulation software techniques has been an important contributing factor. For example, student modeling has proven difficult to implement, for different reasons, with either procedural or declarative languages. A neural network paradigm would allow a fresh approach to be taken. A neural network could be used to "observe" a student's performance to form a dynamic, internal representation of acquired task knowledge and skills. This would provide a necessary element for student performance measurement. There are problems with neural network applications, however. Speed of neural network training is a critical factor in permitting real-time performance.

The main areas of research in artificial neural networks involve search, representation, and learning. Of the three, representation and learning have received the most attention. Research into representation is the study of how information is stored in a network. Research into learning is the study of the process of network-representation encoding. Research has been performed which examines internal representation during learning, but few conclusions can be drawn which link changes in internal representation to the process of representation encoding to improve learning.

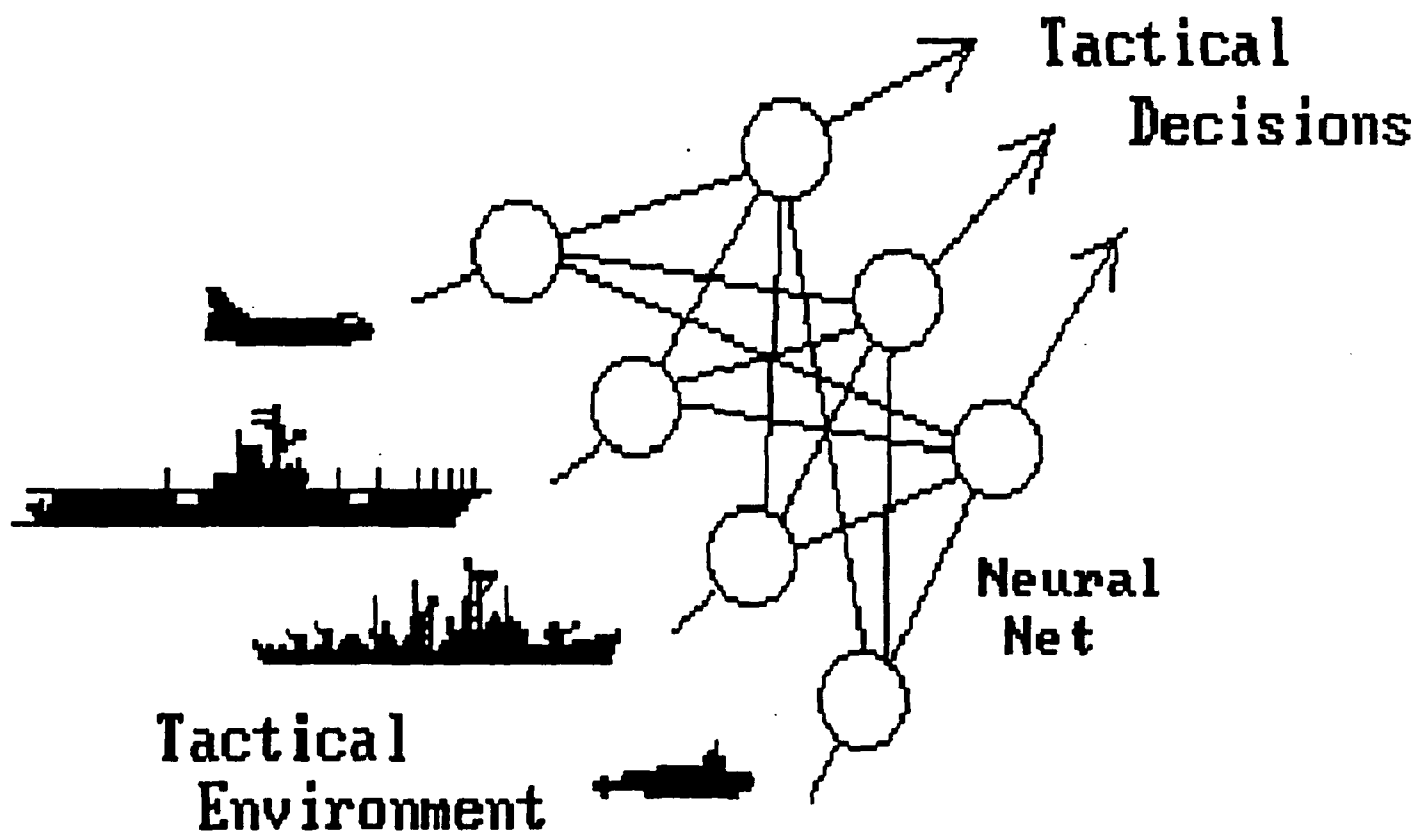
OBJECTIVE: The objective is to investigate the dynamic internal representation of a network being trained in order to capture information which could be used to optimize the learning process. The goal is to develop a faster training algorithm.

BENEFITS: Our data indicate that any application using standard backpropagation is a good candidate for incorporating our algorithm to achieve a significant decrease in training time. Complex pattern recognition problems, involving steady improvement over tens of thousands of trials, are primary candidates. The probability of our algorithm favorably impacting their performance is very high.

STATUS: This IR task was performed in FY90 and FY91. Data visualization techniques were used to describe a multi-layer neural network during training. An hypothesis concerning the relationship between learning rate coefficients and nodal learning level was formulated after analysis of the visual descriptions. A new approach to training neural networks was developed to test this hypothesis. The new approach was tested on the original problem and on several commonly used benchmark problems to determine its utility and generality.

It was hypothesized that overall training time could be decreased by reducing neuronal transitional periods. The mechanism for implementing this hypothesis involved increasing the rate at which the weights entering a transitioning neuron change, thus increasing its ability to discriminate. The metric used to measure neuronal variation was the standard deviation of a neuron's output classifications.

Increases in baseline learning rate resulted in fewer trials in all cases. Also, the amount of benefit achieved by using the modified algorithm monotonically decreases as the baseline learning rate gets higher.



DISTRIBUTED DECISION MAKING: IMPLICATIONS FOR TRAINING

Principal Investigator - R. Willis

Code 26 Phone: 407/380-4825

DTIC Agency Accession Number: DN701001

BACKGROUND: Sound decision making is of great practical concern for the military. The reality facing decision makers within today's military is that information, authority, personnel, resources, and expertise are distributed among the members of the military team. The opportunity for coordination and communication prior to making tactical decisions has been diminished, in part, due to the pressure from technological developments. While technology has extended the range over which individuals maintain contact, the quickness with which information can be shared, and the corresponding amount of information created, it has not examined the behavioral impact on the users of these systems. As a result, systems have been designed which push operators to the limits of their ability to make decisions in the face of dynamic, hostile, uncertain environments.

Typically, decisions are made by one member at the top of the hierarchy, while members at the bottom monitor and communicate incoming information. No one member of the military team has sufficient information to perform the decision-making task. This is called distributed decision making--information is not completely shared among those with a role in shaping the decision. The majority of tasks are accomplished by several people providing inputs and products to the functional supervisor who may or may not communicate among themselves and the functional supervisor. This remoteness is anticipated to have an adverse effect on decision making.

The distributed decision-making environment is defined as one in which the team members are physically separated from one another and must communicate via electronic means, a situation one would find during a Battle Force exercise. Effective teams are those that can quickly spin their information web connecting the distant members.

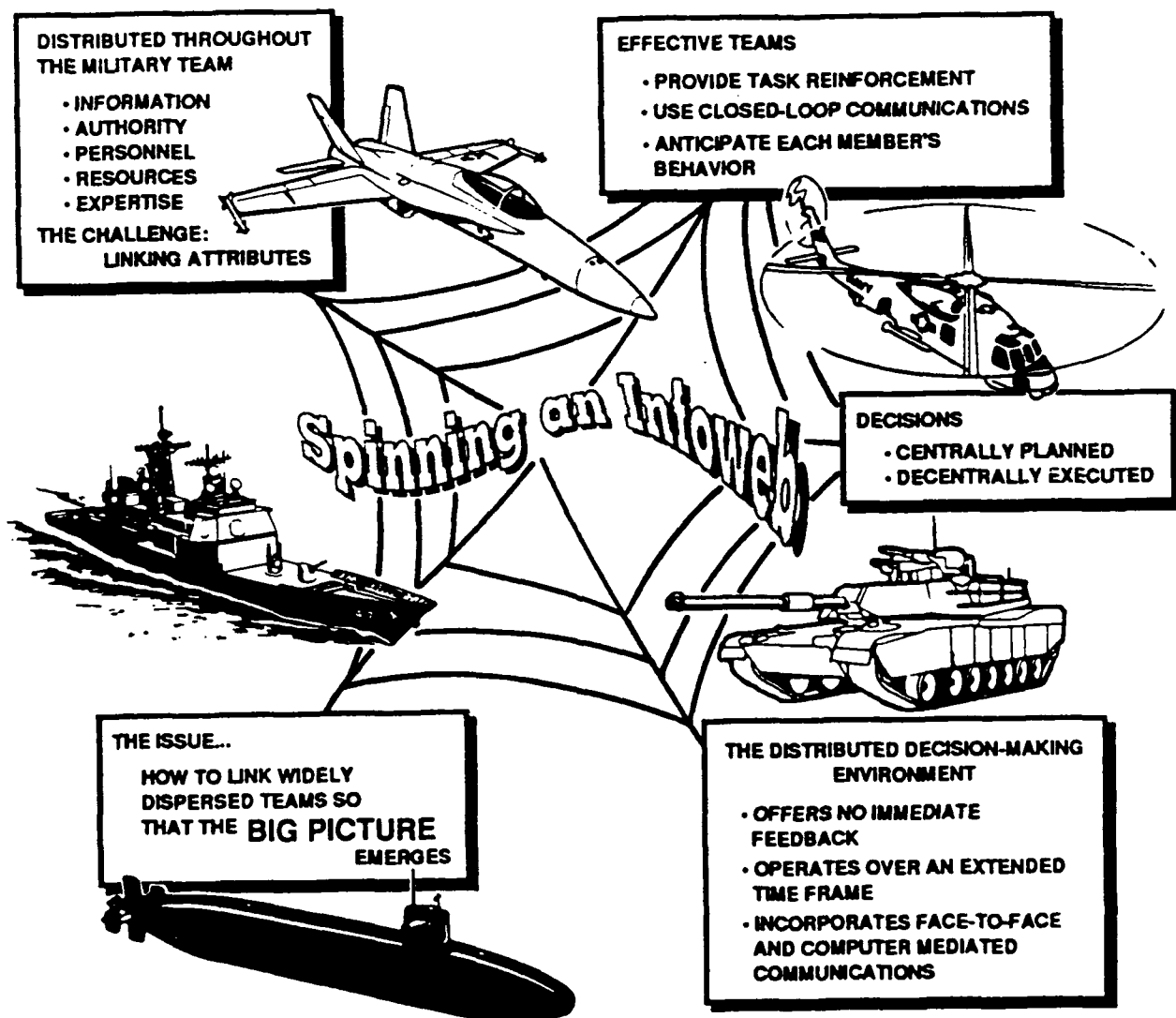
OBJECTIVE: The aim of this research is twofold. First, to investigate factors within the context of distributed decision making that affect the group's decision-making performance. Second, to identify potential training techniques to increase performance in a distributed decision-making environment.

BENEFITS: Successful completion of this research will: 1. delineate factors which lead to effective decision making in a distributed environment; 2. provide recommendations for training techniques to improve distributed decision making; 3. provide human factors data on information limitations to aid in the design of decision support systems. The outcomes of this study could be used by schools to design training curriculum.

STATUS: This IR task was funded in FY91 and will continue in FY92. During FY91 the distributed decision-making environment was defined and factors that have the potential to affect distributed decision making were identified. A series of experiments has been designed to study the impact of the physical separation of the team members on communication, coordination, and decision outcomes using the Team Training Assessment Battery.

MAJOR MILESTONES:

Conduct Decision-Making Experiments	FY92
Altering Social Cognition of Team Members	
Present Research Results	FY92
Publish Research Results and Recommendations	FY93



LOW COST AVIATION VISION TRAINER

Principal Investigator - LCDR E. Trautman

Code 26 Phone: 407/380-4839

DTIC Agency Accession Number: DN701004

BACKGROUND: Visual performance requirements challenge the most capable aviator. High speed, low altitude, and a variety of potentially hostile threats contribute to this difficult environment. Many aviation mishaps are directly attributable to human visual limitations. In addition to the basic classroom lecture, a diverse array of training aids have been used by the military over the years. Instruction using these devices was typically conducted in darkened classrooms at fixed site locations.

Aviation vision training requires the support of modern training devices. Demonstrations of visual phenomena, problems, and illusions are generally regarded as the most significant element of basic vision training. The demand for low cost, portable instructional support devices continues to increase and improved portable basic vision training aids are required. This effort revisited the traditional aviation vision training topics and explored the potential of recently available technologies as candidates for presenting instructional materials in low cost, classroom free, virtual dark class environments.

OBJECTIVE: The objective was to review the current vision topics for aviation training and to explore the potential of recently available technologies as candidates for presenting instructional materials in low cost, classroom free, virtual dark class environments.

BENEFITS: This effort provided the first step in redefining topic and equipment requirements in this important area of aviation training. Documentation of the survey, the proceeding of the symposium/workshop, and conclusions from the experimental device will be of immediate relevance for improving on-going aviation physiology training.

STATUS: This IED task is completed. Fleet users have been surveyed regarding the operational frequency of currently instructed vision related problems. The findings of the survey were published in a NAVTRASYSCEN technical report and in the Proceeding of the Sixth Symposium of Aviation Psychology. A technical symposium/workshop was conducted which assembled approximately fifty vision researchers and aviation physiology trainers for discussion of these topics. The information presented by the symposium's invited experts will be documented as a proceedings of the conference. The same information will be included in a revision of the prototype training pamphlet currently under review by aviation physiology students. These two efforts provide additional verification and augmentation of the taxonomy of vision topics for aviation physiology training.

Development of a low cost demonstration device has progressed as scheduled but is not complete. Equipment has been purchased and the information available in the above efforts has been reviewed for appropriateness in a virtual image based demonstration.

**ASSESSMENT OF IMPLEMENTATION METHODS
IN ADA TASKING FOR SIMULATION**

Principal Investigator - J. Rubel
Code 25 Phone: 407/380-4605

DTIC Agency Accession Number: DN701005

BACKGROUND: The Ada language provides tasking facilities to enhance modeling of concurrent activities found in the real world. Software developers generally refrain from using this Ada task model. The reasons seem to be 1) an increased technical risk due to a lack of first-hand knowledge of high level language tasking methods; 2) concern for real time performance degradation supposedly caused by tasking; and 3) deficiencies found within the tasking model brought to the attention of the Ada community and which are currently being addressed by Ada-9X.

The Ada language provides a functional model of parallelism and provides facilities for several methods of implementation. Ada tasking has various constructs for performing polling operations, selective waits, and timed and conditional entries. Ada's synchronization mechanism (rendezvous) has associated performance considerations as does the use of Ada's exception handling feature used within rendezvous. Many claims have been made as to the deleterious effects in the use of these constructs. Many implementors are refraining from the use of the Ada tasking model due to these, sometimes unsubstantiated, claims.

OBJECTIVE: The objective of this task was to determine the applicability and effectiveness of the Ada tasking model in simulation. Specifically, the intent was to investigate the various Ada task constructs and implementation methods to determine their associated time penalty or overhead costs.

BENEFITS: This effort has provided an important framework for understanding the implementation methods involved with the design and programming of parallel activities, as well as some of the potential pitfalls. NAVTRASYSCEN personnel have gained insight into the inequalities of validated Ada compilers in terms of capabilities, scheduling algorithms, performance, and other pragmatic issues. The developed benchmark programs provided results which indicate the quality of the Ada tasking implementations in terms of performance and specific capabilities related to the microcomputer environment.

STATUS: This IED task is completed. Benchmark programs were designed, developed and executed using various Ada compilation systems and were executed in the two operating environments. An attempt was made at the conversion of a major Ada benchmark program which was retrieved from the SIMTEL20 Ada repository. This program was successfully converted to run on the VAX 785 computer executing under VMS. The program was compiled successfully on the microcomputer, but failed on execution due to excessive storage requirements. Additionally, the Ada Dhrystone benchmark program was retrieved from the Ada repository and was compiled and executed on the microcomputers on which the benchmark programs were executed. The Dhrystone program results help to establish a solid foundation for the comparisons.

The results indicate that much disparity exists among the implementations of the validated Ada compilers. Tasking performance and overhead costs for specific constructs varied more from Ada vendor's compiler implementations of the standard language than from the use of some specific tasking construct.

MAJOR MILESTONES:

A Suite of Benchmark Programs which
Test the Ada Tasking Facilities
was Developed

FY91

**ASSESSMENT OF THE TRAINING EFFECTIVENESS OF
DUAL DISPLAY COMPUTER BASED TRAINING FOR
WEAPONS SYSTEMS WITH GENERIC MAN-MACHINE INTERFACES**

Principal Investigator - M. Williams

Code 22 Phone: 407/380-4681

DTIC Agency Accession Number: DN701003

BACKGROUND: Modern submarine and anti-submarine weapons systems are becoming more complex and more computer-reliant. Computer processing capabilities have dramatically increased over the last decade and this has increased the amount of information presented to the weapons system user. In an effort to standardize weapons system equipment, interfaces, and use, many weapons systems (e.g., P3C Update IV, Seawolf) have chosen to use modularized, programmable operator stations. These stations, usually containing a high resolution display and one programmable entry panel, provide the user with a uniform method of interface with the weapons system, regardless of the station's function.

Because the operator can no longer see and access all knobs, switches and indicators directly, but now must use a computer interface to access software "switches" and "indicators," a need has arisen for increased training in the use of the interface between the user and the computerized weapons system (hereafter referred to as the "man-machine interface").

OBJECTIVES: The objectives are to investigate the most effective use of a low cost computer-based trainer to teach fleet personnel in the use of a weapons system with a generic man-machine interface; to evaluate the transfer of training to the weapons system trainer which uses a generic man-machine interface; and to study the most effective tutorial screen designs and training scenarios.

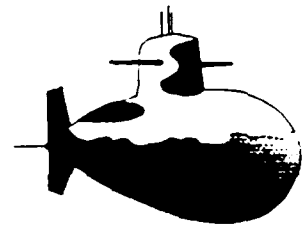
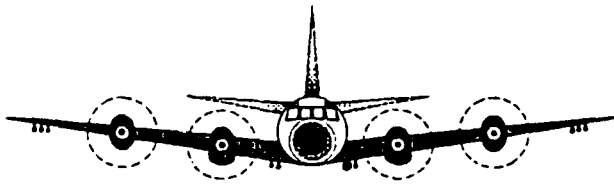
BENEFITS: Successful completion will decrease the time necessary for familiarization training on expensive complex simulators. The availability of complex weapons systems trainers and part-task trainers for weapons system analysis and tactical application training will increase. The new operator will become more proficient in the use of the trainer and utilize the system's full capabilities.

STATUS: This IED task was funded in FY91 and will be funded in FY92. A task analysis was centered around the P-3C UPDATE IV weapons system currently in development and started with the help of the Man-Machine Interface (MMI) Specifications provided by Boeing. The MMIs were studied and the information was molded into a pictorial/text informational database on the developmental computer system with the use of an application software program entitled "Toolbook" by Asymetrix. This effort was initiated in order to better understand and convey the operation of the menu system of a plasma entry panel. Software design and development is progressing and greater emphasis on human factors is being incorporated in it.

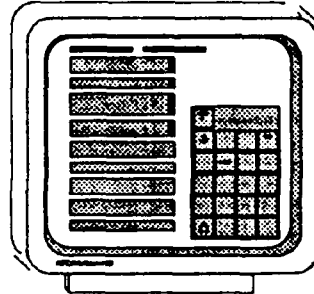
MAJOR MILESTONES:

Task Analysis Completed	FY91
Hardware Design Completed	FY91
Complete Detailed Software Design	FY92
Hardware/Software Integration	FY92
Developmental Testing	
Publish Findings	FY92 and FY93

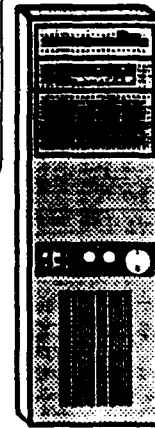
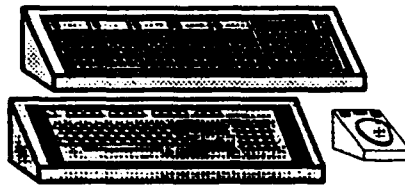
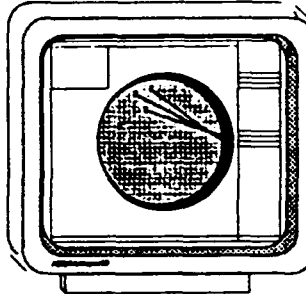
Generic Man-Machine Interface (GMMI)



Tutorial Display



Tactics Display



COMPUTER-AIDED ENGINEERING SPECIFICATION EDITING TOOLS

Principal Investigator - J. Oriel

Code 21 Phone: 407/380-4808

DTIC Agency Accession Number: DN701002

BACKGROUND: The DoD spends billions of dollars each year on engineering changes, contract claims, and modifications to recently purchased items. In many cases, these costs could be avoided if weaknesses in the engineering specifications were found and fixed before contract award. NAVTRASYSSEN has developed some software to scan draft engineering specifications to identify some of these weaknesses quickly, thoroughly, and accurately.

Three software programs are presently in use for this application: PARANA, CkList, and SpecTrE. PARANA facilitates the checking of paragraph numbering, cross references, and references to government documents. CkList checks specifications for certain types of error-prone wording and annotates a hard-copy listing with short comments and suggestions. SpecTrE highlights the error-prone words and phrases on the personal computer screen and displays relevant articles from a hypertext knowledge base.

OBJECTIVE: The immediate objective is to continue enhancing an experimental lexicon and natural-language parser that have been added to a CkList-style program, and to develop a semantic processor and a method of representing the knowledge extracted from the text of draft training device specifications. In addition, a new rule set that examines the specifications for errors will be developed.

BENEFITS: Once developed and in use, user-friendly software based on these techniques will reduce cost growth in training systems procurement by helping government engineers produce high quality engineering specifications and statements of work. This technology could be applied to other sectors of government procurement as well. To do so would only require tailoring of the lexicon and rule set. The Civil Engineering Research Foundation has expressed interest in this task for possible application to construction specifications. Representatives of the following organizations have also expressed an interest in this work: The Defense Quality and Standardization Office, The Naval Weapons Center (China Lake), The Naval Explosive Ordnance Disposal Technical Center, The Naval Ship Systems Engineering Station, The National Institute of Standards and Technology, and the Department of Transportation of the State of Florida.

STATUS: This IED task was funded in FY91 and will be funded in FY92. There are two domains of effort to this task. The first is the study of literature that relates to specification writing and the gathering data by examining drafts of NAVTRASYSSEN specifications. The literature comes from a variety of fields: rhetoric, technical writing, legal writing, specification writing, computational linguistics and human communications, to name a few. This "knowledge engineering" part of the task is needed in order to learn more about what makes specifications good or bad.

The other domain is experimentation with software techniques for automating the examination process. So far, this effort has concentrated on analyzing the syntax of specification sentences. The present version of the parser is a context-free "chart" parser coded in Microsoft QuickBasic 4.5 during FY91. The phrase structure grammar used by the parser was also produced in FY91. Despite its ability to parse only to phrase-structure rules, the parser yields information on sentence structure sufficient to generate reasonably accurate warning messages about certain error-prone types of syntax. However, to parse English with sufficient accuracy to achieve a measure of "understanding" of the text will require the addition of a feature called "augmentation." Adding

augmentation also requires further enhancing the lexicon, giving it separate entries for each inflected form for verbs and nouns, and also giving it additional information about syntactic minutiae that are lexicon-sensitive in English. Information about semantic categories must be added to the lexicon as well. An additional lexicon will be developed to catalog the commonly occurring noun-noun constructs that are so often found in trainer specifications. Following the augmented parser, a semantic processing phase will also be added.

The FY 92 effort aims to build a knowledge-base representing the information contained in the text of the entire document. Methods of globally checking specifications for inconsistencies will be explored.

MAJOR MILESTONES:

Demonstrate Application of Natural Language Parsing to Specification Analysis	FY91
Implement Augmented Parser	FY92
Demonstrate Software with Enhanced Rule Set	FY92
Demonstrate Consistency Checking Capability	FY92
Technical Report	FY92



REAL-TIME ESM SIMULATION SIGNAL GENERATION WITH COTS HARDWARE

Principal Investigator - D. Dyke
Code 21 Phone: 407/380-4113
DTIC Agency Accession Number: TBD

BACKGROUND: A variety of skills associated with the operation of electronic warfare (EW) and electronic warfare support measures (ESM) equipment requires simulation of the electromagnetic environment. The techniques currently in use are varied. The newest systems utilize general purpose computers for "housekeeping" functions, and special purpose digital hardware for the electromagnetic environment simulation. For example, a recent attempt to satisfy the submarine ESM on-board training requirements was unsuccessful primarily due to the inability of the prototype to provide a sufficiently dense signal environment utilizing real time simulation techniques. Current training requirements can require generation of over 1 million pulses per second, each requiring a 64-bit pulse descriptor word.

OBJECTIVE: The objective of this effort will be to develop and demonstrate the simulation techniques required to simulate a dense electromagnetic environment, in real time, utilizing emerging commercial off-the-shelf (COTS) hardware. A secondary objective is to achieve these results with a low cost system with potential for use in portable applications. The effort will focus on real time generation of the pulse descriptor word files which are used in the actual generation of the radio frequency (RF) signals.

BENEFITS: This effort will further ESM simulation technology in the areas of simulation fidelity, real time performance, and the adaptation of emerging reduced instruction set computer (RISC) technology to simulation problems. The technology will advance the knowledge base of real time simulation techniques and emerging COTS hardware potential in the area of EW simulation. Potential benefits are the possible development of real time capable on-board EW simulators, reduced dependence on special purpose/proprietary hardware, other applications for the reusable software. The result will be better training at lower cost.

STATUS: This is an IED two-year effort to begin in FY92. The planned approach is to review the future EW training requirements with respect to the electromagnetic environment simulation. From these efforts a set of EW baseline training objectives will be developed and used to determine performance requirements for the demonstration. The software and hardware architecture most suited to the requirements will be designed and developed. Hardware emphasis will be placed on performance, cost, compactness, and portability. Software emphasis will be to ensure reusability for future hardware architectures.

The hardware and software will demonstrate the capability to generate a dense electromagnetic environment simulation in real time. Pulse descriptor word files generated in real time will be compared to files generated by existing non real time systems. The results would be compared for validation of the accuracy of the real time simulation techniques.

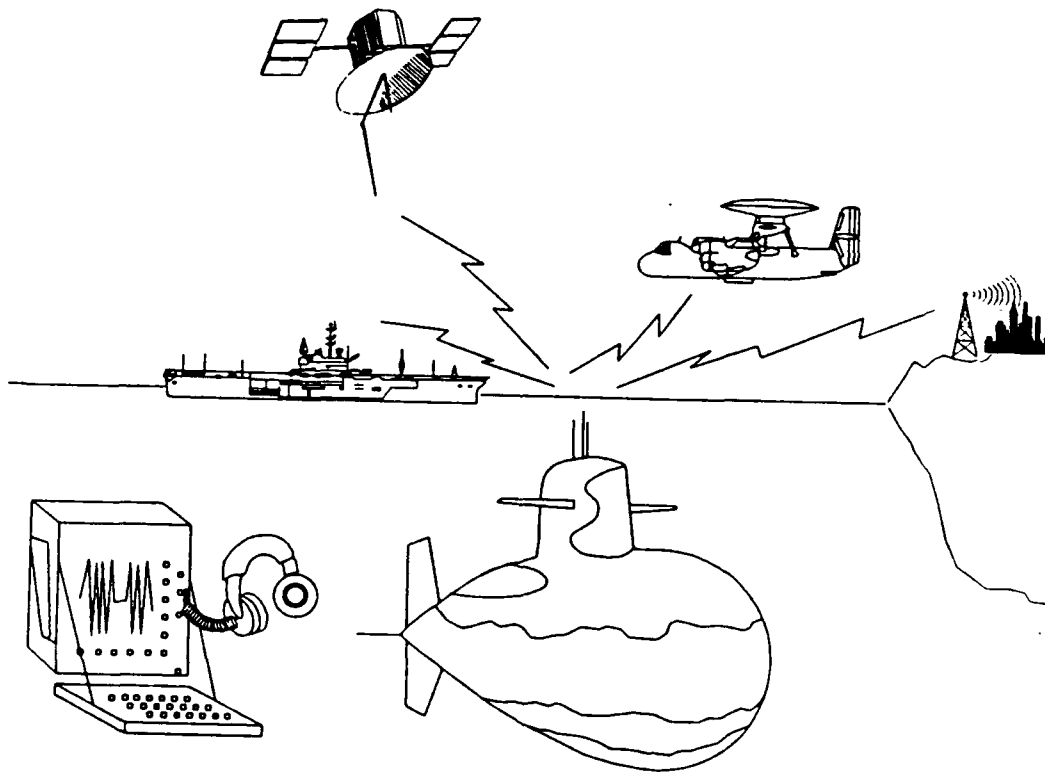
MAJOR MILESTONES:

Develop EW Baseline Training Objectives FY92

Develop Software FY92

Demonstration of Software and FY93

Hardware to Generate A Dense
Electromagnetic Environment
Simulation in Real-Time



**JOINT-SERVICES R&D PROGRAM
PROGRAM ELEMENT 0604722S**

The objective of this program element is to expedite the prototype development of new training technologies and joint-service training data systems that improve training effectiveness and enhance the performance of the military forces. The program was established by the Secretary of Defense to improve training, performance, and readiness of the military departments and reserve components. It also saves DoD funds through the sharing of training and performance information as well as the transfer of emerging and innovative training technologies among the services and private sector. The payoff includes early identification of successful single-service efforts that can be employed on a multi-service/DoD-wide basis for improvement of military operations and training.

NAVTRASYSCEN has one task under this program element, which is described on the next page. The task was approved by a Joint Services Committee and is managed by the Training and Performance Data Center.

WEAPONS TEAM ENGAGEMENT SIMULATION

Principal Investigator - A. Marshall

Code 25 Phone: 407/380-4653

BACKGROUND: This task represents one phase of a broad effort to improve the effectiveness and realism of training a weapon fire team in a simulator environment. Currently, simulator-based team trainers use technology which restricts both realism in tactical training situations and ability for thorough performance measurements. The overall goal of this task is to introduce new technology and techniques which can improve current team training system technology. These new developments include interactive aggressor targets and a high speed weapon tracking system. NAVTRASYSCEM has developed an experimental model which allows two trainees to engage aggressor targets which are presented on a large video projection screen.

OBJECTIVE: The objective of this task is to develop new technology and techniques to improve current team training systems.

BENEFITS: A typical trainee can expend over 5,000 rounds of ammunition during one week of live fire training, which is estimated to cost \$905.00. In addition to the savings in ammunition, other benefits are savings in the cost of facilities, ranges, fuel, and transportation to and from the live fire ranges. Safety is also a concern, since the WTET uses no live ammunition, the dangers of an inadvertent weapon discharge or lead poisoning is eliminated.

Continuously tracking weapon aiming points for all members of a fire team expands performance measurement and playback capabilities. Training effectiveness and realism are also increased by instantly removing disabled aggressors from the training scenario, and requiring trainees to take appropriate cover when an aggressor returns fire. This results in an increase in communication and awareness between members of the team. In contrast, previous training systems did not require trainees to seek appropriate cover. Also, aggressor targets were not removed from the progressing training scenario when they were successfully engaged and disabled by trainees.

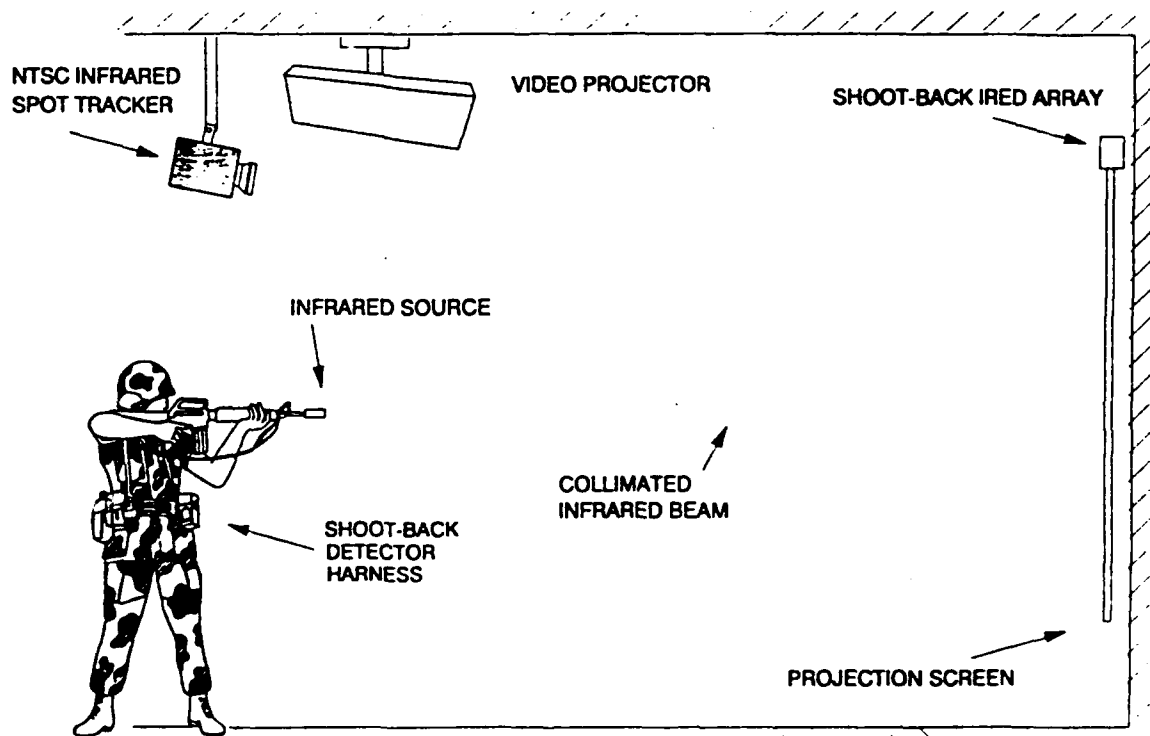
When completed, the system will include tracking trainees' movements to both control shoot-back and enhanced feedback, video recording of the trainees, an expert system to control the video scenarios, and an analysis of the results for debriefing using an expert system.

STATUS: The increased realism and effectiveness in simulator-based weapons team training technology was developed under a 6.2 task, and will be demonstrated and tested for interservice use in FY92 and FY93. A test model was developed that will allow two trainees to practice and rehearse close combat training exercises. These exercises include low intensity conflict, light infantry, SWAT, and security operations, with an unsurpassed level of realism and feedback. Typical events might include security operations, hostage rescue, shoot-no-shoot, ambush training situations, and routine law enforcement operations in a common team scenario environment. In the model, aggressor targets are instantly removed from a training scenario as they are disabled by weapon fire from trainees. An array of infrared emitting diodes was placed above the projection screen and a detector harness was developed to detect a modulated infrared beam from this array. This increased tactical realism in training by requiring trainees to seek appropriate cover when engaged by the aggressor targets. An innovative weapon tracking system which generated accurate weapon position data at over 300 Hz was designed and constructed. This device is capable of continuously tracking weapon aiming points for up to 9 trainees.

MAJOR MILESTONES:

Demonstrate 2-man Weapon Team Trainer FY91

Demonstrate 9-man Weapon Team Trainer with Advanced Features FY92



Weapons Team Engagement Trainer Configuration

SMALL BUSINESS INNOVATIVE RESEARCH (SBIR) PROGRAM PROGRAM ELEMENT 0605502N

The Department of Defense (DoD) SBIR program was developed to stimulate technological innovation in the private sector, strengthen the role of small business in meeting DoD R&D needs, foster and encourage participation by minority and disadvantaged persons in technological innovation, and increase commercial application of DoD supported R&D results. Small business firms with strong R&D capabilities in science and engineering are encouraged to participate in the program. Subject to availability of funds, the program supports R&D proposals for innovative concepts related to important defense-related scientific or engineering problems.

The SBIR program is a 3-phase program:

Phase I is to determine the scientific or technical merit and feasibility of ideas. This will typically be one-half person-year effort over a period not to exceed six months. Successful completion is a prerequisite for funding in Phase II.

Phase II awards are made on the basis of results from Phase I and on the scientific and technical merit of the Phase II proposal. This phase is the principal research or R&D effort. Proposers are asked to consider whether the R&D they are proposing also has commercial possibilities. If so, proposers are encouraged to obtain a contingent commitment for private follow-on funding to pursue further development of the commercial potential after the government funding phases. Phase II typically covers 2 to 5 person-years of effort over a period generally not to exceed 24 months. Phase II is expected to produce a well defined deliverable product or process, and a more comprehensive proposal is required.

Under Phase III, non-federal capital is expected to be used by the small business to pursue commercial applications of the R&D. This phase is designed, in part, to provide incentives for converting federally-sponsored R&D innovation in the private sector.

To request copies of the SBIR solicitation, contact the Defense Technical Information Center, Attn: DTIC/SBIR, Bldg 5, Cameron Station, Alexandria, VA 22304-6415; telephone 1-800-368-5211 (Virginia, Alaska and Hawaii call 202/274-6902.) The solicitation provides information on how to submit proposals.

Phase I efforts are described on pages 50 through 53, and Phase II efforts are on pages 54 through 60.

**TEXTURE MODELING TECHNIQUES FOR SIMULATION OF
INFRARED SENSOR DISPLAYS FOR MISSION PRACTICE IN
NIGHT/LOW VISIBILITY CONDITIONS**

Principal Investigator - J. Booker
Code 25 Phone: 407/249-3122

OBJECTIVE: Develop computer image generation (CIG) texture models to assist programmers during development of real-time infrared (IR) displays to be used for mission practice under night/low visibility conditions. Use of texture can increase realism and reduce programming costs associated with development of CIG IR data bases used in simulation weapon system trainers IR avionics and/or other part task avionics simulators.

DESCRIPTION: The use of CIG texture techniques can enhance realism and reduce program development time required to produce data bases for IR sensor displays. Current IR simulation methods use physical models to compute the temperature of geometrically simulated 3D objects and terrain in an off-line, non-real-time mode, in order to predict the shade/intensity of surfaces appearing in real-time IR displays. The use of texture patterns to fill displayed polygons in the real-time mode can reduce programming complexity while increasing visual complexity of displayed terrain. Reductions in program complexity translate directly into reduced programming and development cost for CIG data base development.

This task should investigate the use of texture patterns in simulation of IR imagery for various types of terrain using current computer graphics workstation technology in non-real-time during Phase I, and develop a proposal providing extensions to allow real-time simulation for Phase II.

**KNOWLEDGE-BASED INTELLIGENT TUTORING SYSTEM (ITS)
DEVELOPMENT TOOL FOR TABLETOP TRAINING SYSTEMS**

Principal Investigator - T. Kopke
Code 25 Phone: 407/380-4589

OBJECTIVE: To design and develop a low-cost, intelligent, tabletop trainer development system. The system would enable rapid prototyping of ITSs.

DESCRIPTION: Intelligent Tutoring Systems (ITSs) typically take a significant amount of time and resources to develop. Some of the components, such as those that manage the training session and student performance, could be predefined so that ITS development would take less effort. The tool itself should be based on expert system technology, both for control over the development environment and for final ITS execution. Given such an ITS development tool on a low-cost, tabletop computer system, the course writer need only concentrate efforts on the specifics of the information to be learned by the student. As a result, development of tabletop trainers would require significantly fewer resources, enabling greater deployment of the technology.

**GAS MASK SENSOR TO DETECT
WHETHER MASK IS FULLY SEALED**

Principal Investigator - R. Carson
Code 26 Phone: 407/380-4829

OBJECTIVE: Develop a detection device for use with a gas mask to determine if the mask is fully sealed. The device is to be used in training exercises to enhance performance of the mask donning task and provide objective feedback.

DESCRIPTION: The ability of personnel to don the gas mask quickly and effectively is basic to survival in a chemical environment. Although the protective mask is the single most crucial article of chemical defense equipment, there is no current training-effective shipboard method for mask donning drill. Mask training currently takes place during Recruit Training. The training consists of entering a tear gas chamber while wearing the sealed mask, breathing through the filter a few times, and then removing the mask so that the contrast with the protected state is appreciated. This method of training is not feasible for a shipboard environment. Also, research has indicated that the tear gas chamber exercise sometimes decreases confidence rather than promoting it. This occurs because many students are unable to seal their masks, but they do not report their failure for fear of having to repeat the exercise. Use of a sensor to indicate whether or not the mask is fully sealed would provide objective feedback to the mask wearer as well as to the instructor. The immediate and objective feedback provided will greatly enhance the mask donning practice.

**HIGH DEFINITION TV PROJECTION VIA
SINGLE CRYSTAL CRT FACEPLATE TECHNOLOGY**

Principal Investigator - R. Hebb
Code 25 Phone: 407/380-4578

OBJECTIVE: To perform research for the design and construction of high performance full color video projection system using single crystal phosphor faceplate technology.

DESCRIPTION: Single crystal phosphor faceplates have been the object of research directed toward producing high resolution, high brightness video projection CRTs. Improved video projection systems are needed for use in applications ranging from flight simulation displays to command and control displays. Current research of Ce:YAG single crystal phosphors has promise of producing a 3 inch diameter CRT faceplate capable of outputting 2000 lumens of light across a wavelength range of 470-670 nanometers (peak output @ 530nm) and displaying up to 4000 scan lines per frame. Further research is required for improvement in the light output efficiency and schemes for color delivery in order to design and construct a full color high performance video projection system. Successful completion of this effort should result in a color video projection system with increased brightness and resolution from a smaller physical footprint and at a lower cost than current high performance video projectors.

**LOW COST HEAD/HELMET
MOUNTED DISPLAY FOR SIMULATION**

Principal Investigator - T. Kopke
Code 25 Phone: 407/380-4589

OBJECTIVE: The objective of this effort is to perform a feasibility design study of a low cost, wide field of view head/helmet mounted display.

DESCRIPTION: The recent development of reconfigurable cockpit technologies, part task trainers, and new proposed virtual reality systems have suffered from a lack of a cost effective visual display system. In applications that would benefit from the use of helmet mounted displays (HMD), the cost and capacity of current HMDs can be a limiting factor system effectiveness. Additionally, the cosmetic appearance of the HMD may doom the entire display systems to failure. There are no HMDs available that have a wide field of view, high resolution, low cost, and a cosmetically acceptable design. A paper study of potential technologies is currently underway. The final HMD system would allow visual simulation in devices where dome display systems are not practical or affordable. Because of the emphasis on low cost, training with out-the-window visuals could then be performed in a low cost simulation environment, thus allowing additional training opportunities.

**LOW COST SYSTEM FOR VERIFICATION OF THE CUEING
FIDELITY (MOTION/VISUAL/INSTRUMENTATION) OF A TOTAL SIMULATOR**

Principal Investigator - B. Browder
Code 25 Phone: 407/249-3121

OBJECTIVE: To satisfy the requirement for a low cost system that will verify that a simulator has met "end-to-end" cue fidelity requirements in its visual, motion, and instrumentation subsystems.

DESCRIPTION: There is currently no unified system or procedure that verifies that a simulator has met design requirements for cuing fidelity in its visual, motion, and instrumentation subsystems. Generally, pilot feedback and selected testing of some hardware is the only quantitative measure of the total dynamic behavior of the simulator.

**SUBJECT MATTER AND PEDAGOGICAL EXPERTS FOR
TRAINING DEVICE CURRICULUM DEVELOPMENT AND CONTROL**

Principal Investigator - R. Breaux

Code 25 Phone: 407/380-8168

OBJECTIVE: To embody general teaching principles in a teacher expert system that will query subject matter experts for principles, examples, performance indicators and qualification thresholds, then to conduct and refine the course of study. This expert system teacher would be reused to develop curricula for various new training devices or for modifications to existing devices.

DESCRIPTION: The teacher of a class of students often is restricted in the amount of individual attention given to each student's needs and, therefore, attempts to optimize for the class. A teacher with a single student selects a teaching strategy based upon an inference of the student's learning stage from an evaluation of the student's performance. Teaching is carried out by generation of examples and explanations, and verified by generation of questions and problems. Speed and accuracy are often used to measure progress. The teacher must also create the syllabus. Student weaknesses are diagnosed by inference from the errors students make, then exercises are selected to remediate the weakness. Finally, the teacher must allow the student some degree of control, as well, by allowing the student to ask questions. Training device technology will benefit from expert systems which can gather required subject matter from the domain expert, tailor a course of instruction to individual students, and refine the course materials over time. Gathering the domain includes rules for a common error and misunderstandings of students, facts and their relationships, procedures of the domain, examples, theory, and practice. If the domain contains abstractions, then sufficient basis concepts or common sense examples are needed to draw analogies. A hierarchy of concepts is needed so that the teacher can choose top-down vs bottom-up, and breadth vs depth teaching strategies.

LOW COST AUTOMATIC SCENARIO GENERATOR (ASG)

Principal Investigator - B. Pemberton

Code 25 Phone: 407/380-4602

OBJECTIVE: The objective of this effort is to determine the system characteristics and demonstrate the feasibility of a low cost automatic scenario generator (ASG) for aircrew training systems such as the F-14D, A-16, and future forward deployed tactical trainers.

DESCRIPTION: The ASG would replace the current non-automated scenario generation process, significantly reducing the time and effort to create scenarios and, therefore, increase the overall productivity of training systems. In selected cases, an ASG could lead to self-paced student shipboard training.

TRAINING OPTIMIZED UTILIZATION RESOURCE SCHEDULER

Principal Investigator - L. Keeler
Code 25 Phone: 407/389-4627

BACKGROUND: Utilization of a significant number of training devices averages less than 100 hours each per month, although a recent sample survey indicated that device availability was above 90%. Scheduling problems are a major cause for the low utilization/availability ratio and results in increased training cost. Although resource scheduling systems have been built, none available address the multiplicity of precedence, conjoint, and disjoint scheduling constraints typical of a training curriculum.

OBJECTIVE: The objective of this effort is to develop a scheduling tool for use by: curriculum developers and planners testing alternative curriculum mixes; training analysts simulating different training alternatives; and course designers and schoolhouse management personnel responsible for the scheduling of training at individual schools. It would also serve as a repository catalog of training resource and course constraints for all courses and resources at a school.

BENEFITS: A computerized scheduling system capable of addressing these constraints will result in effective and efficient training schedules which will optimize device utilization. Because it will operate on a Zenith-248, its use will be increased throughout the Navy training community. The use of such a tool could improve training device utilization/availability ratios and result in significant trainer acquisition and maintenance cost savings.

STATUS: A contract for the Phase I effort was awarded in December 1990 to define the design approach. The research has identified two kinds of scheduling for scheduling training in the Navy: macro scheduling, and micro scheduling. Although computers are used in the registration process, all macro scheduling is accomplished manually, and computer assisted micro scheduling is limited to one system, the Computerized Aviation Scheduler (CAS), which is limited to use at TRARON-26 and is not easily adaptable to other training units. Development of a scheduling system capable of both macro and micro scheduling, and generic enough for application at a wide variety of Navy training sites is planned for early FY92.

**ON-LINE DIAGNOSTIC SYSTEM
FOR SIMULATOR PERFORMANCE MONITORING**

Principal Investigators - B. Browder/F. Frey
Code 25 Phone: 407/249-3121

BACKGROUND: When a flight simulator is accepted for training, the trainer's visual, motion, and other cue systems meet some established criteria of performance and fidelity. However, as the trainer is used and hardware is subjected to normal wear and tear, the cue systems may begin to slowly degrade from the standards of performance displayed at acceptance. These changes may be gradual and may result in conflicting cues to the student from the motion and visual systems. This cue conflict often results in adverse reaction by the student. Traditionally, student-pilot feedback or routine maintenance checks are the only means of early detection of a trainer's "health" problem. Often, the pilot feedback is inconsistent or boldly contradictory. Thus, an on-line diagnostic system is needed to verify, quantitatively and consistently, whether the simulator continues to meet minimum performance standards or is in a substandard state.

OBJECTIVE: The objective is to provide an on-line real-time diagnostic system for monitoring the "health" state of fielded aviation training simulators. This approach will provide a fast quantitative verification that simulator performance has not fallen below established performance criteria.

BENEFITS: This simulator performance monitoring system will ensure that the motion and visual systems are constantly performing to standards required to provide positive pilot training transfer, resulting in cost savings with more quality per hour of operation. In addition, this monitoring system has the potential to be used as a simulator evaluation tool providing a more thorough acceptance test procedure.

Because the simulator performance monitoring system will constantly check the synchronization of the simulator visual and motion cues, simulator sickness induced by out-of-tolerance cue lags can be avoided. The system can also be used as a maintenance tool to balance the colors and luminance levels in multi-channel display systems. A third application would be as a piece of test equipment that could be used during the acceptance of newly acquired simulators.

STATUS: The Phase I final report has been received and is now in the review cycle. The following is a summary of observations and comments of the final report:

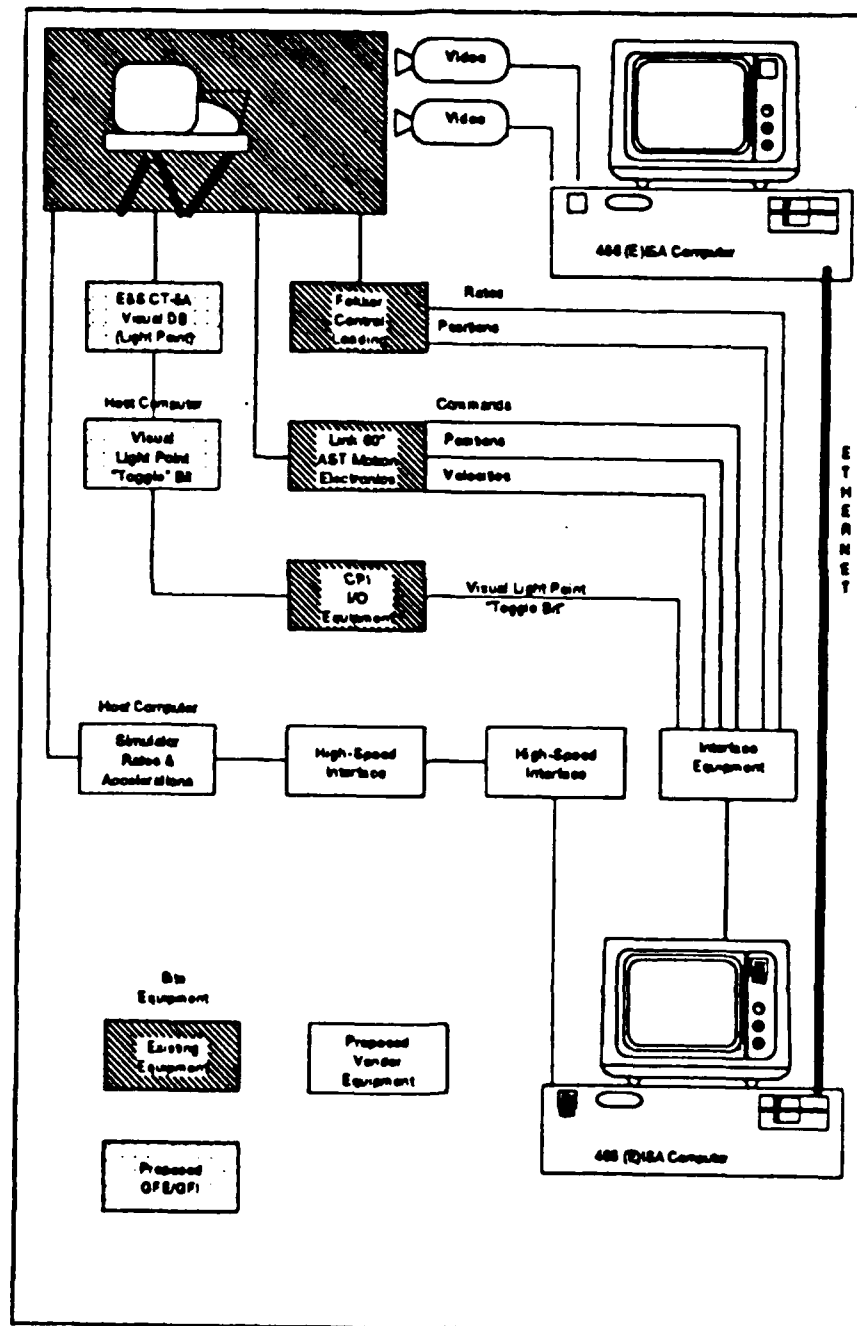
The performance monitoring system, called the Simulator Performance Monitoring System (SPMS), is a generic design that can be rapidly ported to a large number of simulators. The SPMS is composed of state-of-the-art, off-the-shelf microcomputers and video processing equipment.

Although the title implies that the SPMS is used exclusively in an "on-line" mode, some diagnostics must be performed in an off-line mode (monitoring of data taken while the simulator is not in a training mode). One example is the measurement of visual quality where the image generator must supply special test patterns.

State-of-the-art image processing techniques and stochastic processing methodologies are used to perform on-line visual and motion system latency.

On-line helmet position monitoring for better insight into simulator sickness causes will be provided by camera tracking of LED lights mounted on the pilot's helmet.

The CH-53E simulator located at MCAS New River is recommended as the baseline site for implementation of a prototype SPMS for the Phase II effort.



SPMS HARDWARE BLOCK DIAGRAM

REAL TIME PHOTOGRAPHIC BASED TERRAIN IMAGE GENERATOR
WITH CAPABILITIES FOR 3-D OBJECTS

Principal Investigator - J. Booker
Code 25 Phone: 407/249-3122

BACKGROUND: Photo-based image generators have utilized digitized 2-dimensional photographs to produce 3-dimensional perspectives through special processing. This has proven to be adequate for some areas of visual training, where low level flight of high detail terrain queuing is not required. Traditional polygon based image generators lack the fidelity to produce a realistic terrain scene, but have been used extensively for visual training because true 3-D perspective can be accomplished. Today's hardware and software technologies have developed to a point where it may be feasible to design a low cost and efficient visual system which could produce a true 3-D perspective terrain scene from 2-D photographs and elevation data.

OBJECTIVE: The objective is to produce a low cost visual system capable of receiving photographic terrain information, and in conjunction with Defense Mapping Agency elevation data, produce a 3-D real-time image for flight simulation and mission practice applications. The system should also be capable of integrating 3-D moving models and target and ground queuing objects into the scene.

BENEFITS: It is planned that this system would be capable of displaying a wide geographical area at a 30 Hz update rate. The inclusion of 3-D polygons with texture capability onto a photographic based terrain scene would provide enhanced fidelity as well as realistic true perspective scenes. In comparison to traditional polygon based techniques which cost \$1M per channel, photo based terrain with texture is expected to cost around \$150K per channel.

STATUS: Three contractors were awarded Phase I contracts in FY90. Contractors were selected on the basis that each proposed different basic approaches to develop the required system. The contracts have been completed and technical reports received. At least one Phase II contract award is anticipated to be awarded during early FY92, based on results of review of the three Phase I final reports and Phase II proposals.

LOW COST RECONFIGURABLE COCKPIT FOR DEPLOYABLE AIRCREW TEAM TRAINERS

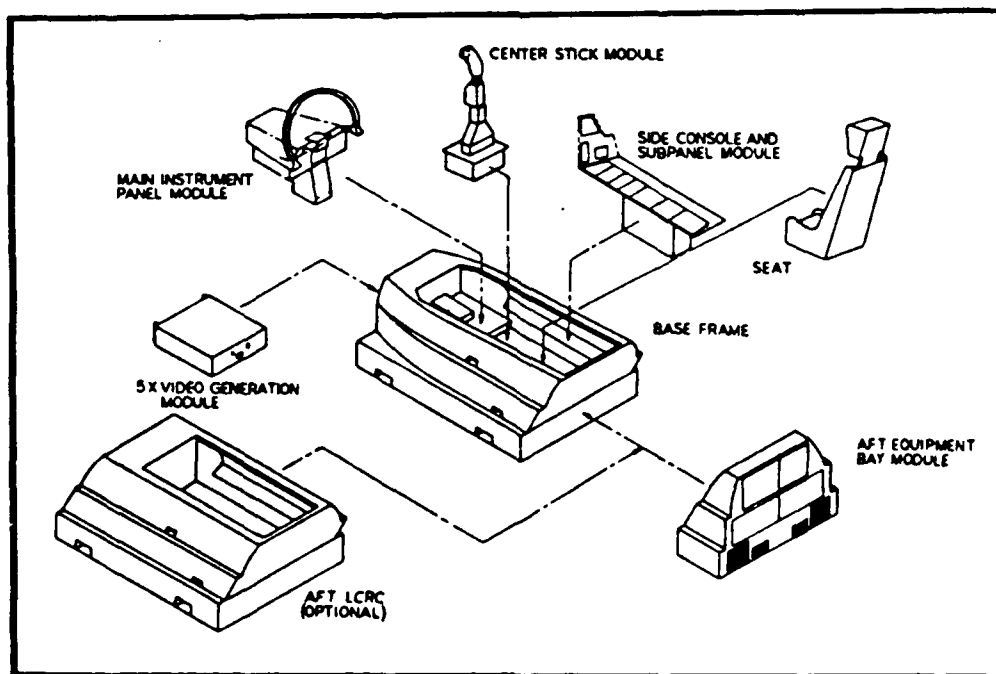
Principal Investigator - T. Kopke
Code 25 Phone: 407/380-4589

BACKGROUND: A low cost, deployable cockpit that can be easily reconfigured to simulate a variety of aircraft is desired. The cockpit instrumentation and controls would be modular in that they could be rearranged inside the cockpit to simulate different configurations. Displays such as the head-up displays, weapon status, and electronic countermeasures would be reconfigurable to simulate different aircraft formats. All aircraft functions need not be represented, but if in a modular design, function could easily be added. The cockpit would then be connected via a proper interface network to a low cost, deployable simulator system for use in team training.

OBJECTIVE: The objective is to design and develop a low cost, modular, reconfigurable cockpit that can be transported to any site and easily reconfigured to simulate a variety of aircraft cockpits. It may be used with other out the window display and simulation computers in deployable aircrew team trainers.

BENEFITS: The development of a low cost simulator cockpit, which can easily be reconfigured to a variety of aircraft configurations, has the potential of reducing cockpit procurement costs at sites where multiple simulated aircraft are used. The savings would be realized in the reduction of purchased cockpits by purchasing components specific to the cockpit being simulated instead of an entire different cockpit.

STATUS: A paper design competition has been completed. The winning approach is a modular architecture with multiple dedicated displays. Actual construction is expected to begin mid 1992.



LOW COST COMPUTER IMAGE GENERATOR FOR NIGHT VISION

Principal Investigator - T. Kopke

Code 25 Phone: 407/380-4589

BACKGROUND: Efforts are currently underway to develop low cost display systems to simulate night vision goggles for use in flight training simulators. A low cost image generator is needed to drive these displays. The computer image generator is different than the usual CIG found in simulation because the NVG display is monochrome. The low cost generator should be capable of displaying night vision terrain for use in flight simulation. The data base created for the low cost CIG will coordinate with an existing daylight data base. Provisions for inputs of flight parameters, data base location, and attitude are required. Since NVG viewing window can change dependent on the simulated flight, a provision for input of head attitude information will be provided.

OBJECTIVE: The objective of this effort is to design and construct a prototype low cost computer image generator.

BENEFITS: The final product will have operating features and performance comparable to image generators that cost \$200K-\$300K currently being used for visual simulation. The target cost will be approximately \$100K for a system that will have photo texturing and true perspective. The lower cost and modular design will allow easy modification to adapt to a variety of low cost simulation approaches while maintaining scene fidelity that is required for many tasks such as NVG training.

STATUS: A Phase II effort is currently underway with a design that incorporates a hyper-cube type technology.

LOW COST NIGHT VISION GOGGLES FOR SIMULATION

Principal Investigator - T. Kopke
Code 25 Phone: 407/380-4589

BACKGROUND: The increased use in night vision goggles (NVG) for flight has prompted the need for night vision flight training. Night vision systems used in flight have a limited field of view and do not allow for use of periphery cues when flying nap of the earth. A low cost display system that mimics operational NVG hardware for simulation training is needed. The low cost simulated monochrome NVG display will have display rates compatible with current flight simulation computer image generators and will be comparable in weight if worn on the head. Optical and physical parameters will be, or similar to, that of operational NVGs.

OBJECTIVE: The objective of this effort is to design and construct two prototypes based on two different display technologies: liquid crystal display (LCD) and cathode ray tube (CRT). The final delivered products will simulate the ANVIS NVG system that would accept standard video from either computer image generation or video disk based image generation systems.

BENEFITS: The final NVG system would allow NVG training in any dome simulator and would not be restricted by display type inside the dome. Because of the emphasis on low cost, NVG training could then be performed in a low cost simulation environment, such as part task or a classroom, allowing additional NVG training opportunity.

STATUS: Phase II efforts are currently underway to construct a CRT and a LCD based system that will operate with standard video inputs.

ANCILLARY FUNDED TASKS

During the normal cycle of program reviews, some Navy R&D sponsored efforts are found by others to contain elements which apply to their own requirements. When this happens, NAVTRASYSCEN examines the similarities and differences in requirements and applications. A determination is made as to whether there is a significant issue and, if so, who is best able to pursue the technology.

Likewise, the Navy trainer community's review of emerging R&D identifies applications which were not considered during technology development. A determination is made as to whether a modification to the on-going effort would allow expansion to these additional applications or to establish a special task.

The tasks in the following section were determined to be pursued best by NAVTRASYSCEN due to special talents, capabilities, or facilities. They may be funded by other Navy activities, other services, or DoD agencies.

ELECTRONIC WARFARE CONTINUUM ASSESSMENT PROGRAM

Principal Investigator - M. Bergondy

Code 26 Phone: 407/380-4777

BACKGROUND: The need to document warfighting readiness and training effectiveness is a major concern for warfare sponsors, operational commands, and training system developers. The Electronic Warfare Continuum Assessment Program (EWCAP) examines EW performance and training effectiveness across the careers of Naval Aviation personnel. Platform specific EW tests are designed and developed through collaboration between fleet subject matter experts and NAVTRASYSCEN personnel. Using a computer based program, the EWCAP tests are administered to all aircrew personnel. The data are reduced and analyzed by NAVTRASYSCEN personnel, identifying strengths and weaknesses within each community and highlighting necessary remedial and training enhancing actions or policies.

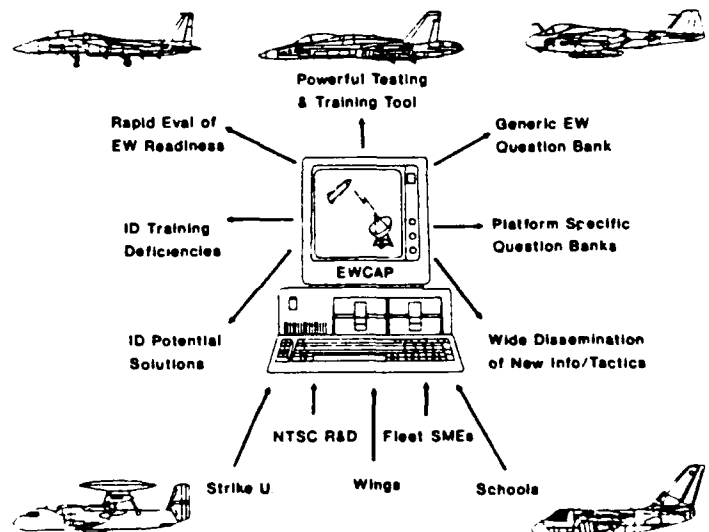
OBJECTIVE: The objectives of the EWCAP are to develop a method for rapid evaluation of EW readiness in Naval Aviation communities, provide to the Chief of Naval Operations and the Naval Air Systems Command documentation of EW performance and training deficiencies, and make recommendations for solutions to identified training problems.

BENEFITS: Each evaluation identifies specific EW strengths and weaknesses within a community. Repeated testing determines whether changes implemented in the training cycle have significantly impacted operational performance. Finally, while the primary goal of the EWCAP is to evaluate skills and knowledge, each test is carefully constructed to offer maximal training benefits through the use of extensive instructional feedback. This feedback provides a vehicle for rapid dissemination and reinforcement of new and revised threat and tactical information.

STATUS: The initial assessments of the EA-6B, F/A-18, A-7, and E-2C communities are completed. The S-3 and A-6 evaluations are currently underway. The initial evaluations of both the F-14 and EP-3 and the retesting of the EA-6B, F/A-18, and E-2C are planned for FY92.

MAJOR MILESTONES:

Complete A-6 and S-3 Evaluations	FY92
Complete Initial Assessments of F-14 and EP-3	FY92
Reevaluate EA-6B	FY92
Reevaluate all Platforms	FY93



PRODUCTIVITY ENHANCING CAPITAL INVESTMENTS
REUSABLE SOFTWARE

Principal Investigator: L. Keeler
Code 25 Phone: 407/380-4627

BACKGROUND: The demand for new software is increasing faster than current approaches to software development are able to supply it. Software development is labor-intensive, and software systems in general are more complex than ever before. The increased complexity of the weapons platforms and weapons systems for which training systems must be designed and built serves to further the requirement for even more complex software.

OBJECTIVE: This task will provide the hardware and software necessary for a Reusable Ada Software Component Repository for Training Systems for the NAVTRASYSCEN. It will include rules and guidelines for use in developing reusable Ada software source code components together with automated tools to assess the adherence of newly developed software to these rules. It will also include an extensible set of reusable Ada software source components to populate a repository, and the requisite hardware and tools for storage, retrieval and configuration management of the components in the repository.

BENEFITS: It has been proposed that a collection of reusable software components could reduce the cost of software development, improve the quality of products, and accelerate software production. Productivity in the range of 20,000 lines of code per man-year as opposed to the average of 2,000 lines of code have been attributed to extensive use of reusable code. More conservative studies indicate that 40 - 60% of the software code written is repeated in multiple applications. If only the most conservative estimates are true, significant savings are realizable if a program for identifying, storing and providing for easy locating and accessing of these reusable software components is made available.

Making reusable software components available to contractors will permit them to bid more competitively while simultaneously improving the software reliability and maintainability. The rules and guidelines and the automated reusability assessment tools will assist both contractor and in-house software developers in developing high quality reusable Ada software components. In addition, these tools will assist software acquisition activities in ensuring that the software acquired in Navy trainer acquisitions meets the quality standards required for reusability. The reusable software repository hardware and its configuration management tools will maintain the reusable software components in an on-line system, while the automated library retrieval system tools will ensure that they may be easily identified and accessed for reuse in future software applications.

STATUS: A contract was awarded to provide a Reusable Ada Software Component Repository, including: a set of reusable flight simulator components for seeding the repository; the requisite tools for storage, retrieval and configuration management of the components in the repository; and an objective set of rules and guidelines specifically tailored for developing reusable Ada components in the training simulator domain. The contractor has recently demonstrated increased tool building capabilities allowing the development of a set of reusability assessment tools.

MAJOR MILESTONES: The following products will be delivered in FY92:

- * Hardware to host an extensible repository of reusable ada source code software components

- * Automated set of tools for cataloguing and accessing ada source code components contained in the repository
- * Set of rules and guidelines for use by software developers in creating reusable ada source code software components which will ensure that these components possess the attributes, features and characteristics which contribute to reusability
- * Automated set of tools for assessing the degree to which ada source code software components possess the attributes, features and characteristics which contribute to reusability
- * Set of reusable ada source code software components possessing the attributes, features and characteristics which contribute to reusability to demonstrate the feasibility of a reusable ada source code archival library

SIMULATOR SICKNESS R&D PROGRAM

Principal Investigator - S. Jones
Code 26 Phone (407) 380-4152

BACKGROUND: Enhanced simulator fidelity has resulted in improved training effectiveness, as well as increased pilot acceptance. However, as the sophistication of simulator equipment has increased, so have reports of simulator induced sickness. To the extent that simulation technology violates principles of human factors engineering, the incidence of simulator sickness may continue to rise. Quantifiable engineering differences exist between training devices which may account for differences in the magnitude and types of symptoms reported.

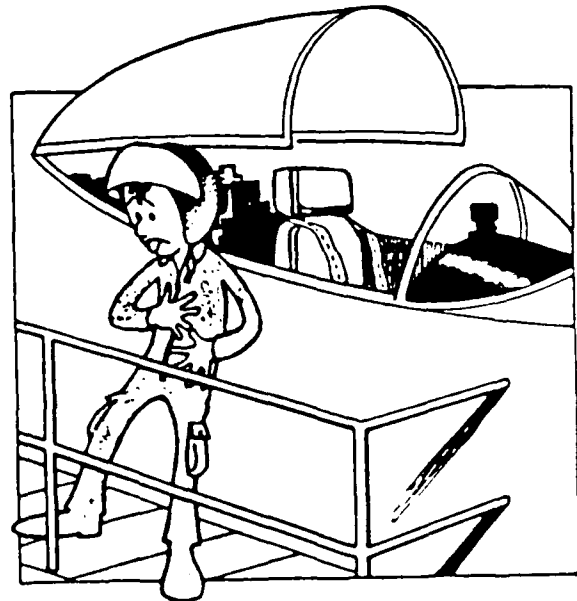
OBJECTIVE: Until improvements in engineering design reduce or alleviate the incidence of sickness in training devices, there is a need to: (1) document and monitor incidence rates to identify which systems induce unacceptably high levels of sickness, (2) relate symptomatology to specific engineering features and/or feature differences, and (3) generate design criteria to be incorporated into trainer specifications, standard acceptance tests and operational test and evaluation procedures.

BENEFITS: Simulator sickness monitoring provides an overall index of sickness and a profile analysis of three symptom clusters: (1) oculomotor (e.g., eyestrain, visual flashbacks), (2) disorientation (e.g., dizziness, postural instability), and (3) nausea (e.g., stomach awareness, vomiting). These clusters represent subscales which carry diagnostic meaning in terms of identifying specific components of the training device that contribute to the problem.

STATUS: NAVTRASYSSEN is currently examining the relationship between simulator engineering features and the incidence of simulator sickness experienced in five rotary and fixed-wing trainers. An engineering test plan has been developed for the purpose of measuring characteristics of the simulator visual display, image generator, and motion hardware, suspected to play a causal role in the onset of symptoms.

MAJOR MILESTONES:

Install Computerized Survey	FY91
Examine Contributions of Motion Display	FY92
Examine Contributions of Visual Display	FY92
Technical Report	FY93



TECHNOLOGY TRANSFER
Point of Contact - J. Weisenford
Code 2B Phone: 407/380-8276

The Federal Technology Transfer Act of 1986 encourages federal research and development laboratories to optimize the investment of tax dollars in R&D by transferring knowledge and products gained to other organizations, both public and private. The Act also provides for joint research projects between federal laboratories and other organizations as well as commercialization of laboratory products. It also promotes federal laboratories to provide technical volunteers to the community in which they are located.

In promoting technology transfer, Congress believes that there will be significant benefits to the public. Congress noted that many government patents were not licensed and, therefore, government inventions were not commercialized. To encourage licensing of government patents, Congress built incentives into the Federal Technology Transfer Act. Government inventors and the laboratories where they work share part of the royalties generated from the commercial use of their inventions. The inventor and the labs profit through this commercialization and our economy is enhanced through manufacturing and sale of new products.

There are benefits to the public from the exchange of knowledge and products within the government. Exchange includes sharing information and products with other federal agencies, as well as with state and local governments. By sharing knowledge and products on a wide basis, the public reaps the benefits from research conducted for one purpose or agency in many new ways. The return on the investment of the tax dollar is increased. To promote the exchange, Congress mandated that each federal laboratory create an Office of Research and Technology Applications.

Another benefit from the Federal Technology Transfer Legislation is the establishment of the Federal Laboratories Consortium. (FLC). This consortium is a network of over 500 federal labs. The FLC is a clearinghouse for technology transfer and a source for helping agencies learn how to transfer technology. NAVTRASYSCEN is a member of the FLC.

NAVTRASYSCEN has a long history of technology transfer to both the public and private sectors. For example, the overhead projector was developed under a NAVTRASYSCEN contract in 1944 to project plot charts for navigation training. The overhead projector is used in nearly every classroom.

Today, the Center is actively pursuing technology transfer through a number of initiatives. Some of the key initiatives are described below.

SERIOUS PURSUIT: A COMPUTER GAME FOR LEARNING ABOUT THE SOVIET UNION

This game was originally developed to teach sailors and soldiers about the Soviet Union. It has been shared with local high schools and universities to enhance their Russian Studies Programs.

CHEMISTRY PURSUIT: A COMPUTER GAME FOR HIGH SCHOOL CHEMISTRY

Studies show that interaction encourages learning and that games increase the motivation to learn. Working with a high school chemistry teacher, NAVTRASYSCEN modified Serious Pursuit so that it quizzes students on high school chemistry. This game is now being given to schools.

Chemistry Pursuit will be distributed nationwide through the National Science Foundation's Project Seraphim, which distributes chemistry software to over 3,000 educators.

COMPUTERS FOR TEACHING ENGLISH

The NAVTRASYSCEN and the Institute for Simulation and Training at the University of Central Florida developed computer courseware to teach English to students who do not read it in their native language. The courseware, Picture This, is being evaluated by Blankner Elementary School, a bilingual center.

PARTNERSHIP WITH BLANKNER ELEMENTARY SCHOOL

Blankner Elementary School has many low income students, including students who come from the homeless shelter. As part of the partnership a NAVTRASYSCEN engineer team teaches a class of gifted children for math and science. Over a two month period, there was a 37% improvement in math test scores.

ADOPTION OF SEMINOLE COUNTY SCHOOL SYSTEM

In addition to adopting schools, NAVTRASYSCEN has adopted an entire school system. The Center will provide consulting services, develop teacher training on new educational technology and on cross cultural communication, explore ways to enhance drivers' education and electronics training, and provide a shell to allow teachers to create new versions of the Chemistry Pursuit game for any subject.

MAITLAND MIDDLE SCHOOL

NAVTRASYSCEN is a member of Maitland Middle School's Educational Technology Committee. Maitland Middle School is expanding the use of computers as tools for teaching. The Center will host faculty and staff from Maitland to share some of the Navy's applications of technology for instruction.

SCHOOL YEAR 2000

School Year 2000 is an initiative of the Florida Department of Education and the Center for Educational Technology at Florida State University to design and implement new models of schooling. NAVTRASYSCEN is assisting with this project as a member of the Policy Advisory Board.

EDGEWATER HIGH SCHOOL'S ENGINEERING CENTER

In 1991, Edgewater High School was designated an engineering educational center for high school students in Orange County Florida. The center is dedicated to increasing the number of students pursuing careers in science and engineering. Introductory as well as college level courses in engineering and science are offered at Edgewater. NAVTRASYSCEN is an advisor to this program, in addition to providing adjunct faculty, mentors, training and laboratory experiences.

NASA AGREEMENT

NAVTRASYSCEN and NASA, Kennedy Space Center, signed an agreement to share

technology. As part of this agreement, NAVTRASYSCEN is developing a prototype interactive courseware system for technical training and sharing expertise in the area of team training.

ORANGE COUNTY SHERIFF'S OFFICE

NAVTRASYSCEN is working with the Orange County Sheriff's Office to share simulation and training technology to enhance law enforcement training.

ORLANDO FIRE DEPARTMENT

The Orlando Fire Department has designed training systems for firefighting based on systems developed by NAVTRASYSCEN. Currently NAVTRASYSCEN and the Fire Department are identifying ways to share Navy emergency medical training systems and Navy fire fighting trainers.

SPECTRE

The Civil Engineering Research Foundation and The Florida Department of Transportation are currently evaluating SPECTRE for use in their contract specifications. SPECTRE is an automated tool for improving contract specifications.

COOPERATIVE R&D AGREEMENTS

NAVTRASYSCEN currently has two CRDAs. One is with Paragon Graphics to develop, integrate, demonstrate, and evaluate helmet-mounted display technology. There have been two demonstrations of the research efforts, with additional demonstrations scheduled. The second CRDA is with Embry Riddle Aeronautical University to evaluate a radio instruments orientation trainer. There are two additional CRDAs in progress for the design and development of a computer game shell, and the development and evaluation of a prototype training system applying the helmet-mounted display technology.

BENEFITS FROM TECHNOLOGY TRANSFER

In addition to the sharing of federally funded research and enhanced commercialization of government inventions, there are other benefits from technology transfer. By sharing Navy training research with the non-DOD public sector, improvements in training and education will occur. The benefits are not just "one way." NAVTRASYSCEN is gaining access to subject matter experts and resources to develop a game shell and to develop a game to teach geography to the Naval Junior Reserve Officers' Training Corps. We are also learning about civilian resources which can be shared with the Navy, such as the public school's teletraining network. The Orlando Fire Department has offered to make the firefighting training systems it developed available to the Navy. NAVTRASYSCEN is also receiving feedback on R&D products which can be used to improve our future systems.

APPENDIX

TERMS OF REFERENCE

ACMI	Aircrew Combat Maneuvering Instrumentation
AIS	Aircrew Instructional System
ASG	Automatic Scenario Generator
ASC	Automatic Scenario Control
CNO	Chief of Naval Operations
CDS	Combat Direction System
COTS	Commercial Off-the-shelf
CIG	Computer Image Generation
CAS	Computerized Aviation Scheduler
CRDA	Cooperative Research and Development Agreement
CSEDS	Combat System Engineering Development Site
DEFTT	Decision Making Evaluation Facility for Tactical Teams
DMA	Defense Mapping Agency
DTIC	Defense Technical Information Center
DoD	Department of Defense
DTATS	Deployable Tactical Aircraft Training System
DDS	Display and Debrief Subsystem
DBS	Doppler Beam Sharpened Radar
EW	Electronic Warfare
ESM	Electronic Warfare Support Measures
EWCAP	Electronic Warfare Continuum Assessment Program
ET	Extra Training
FLC	Federal Laboratories Consortium
HMD	Helmet Mounted Displays
IR	Independent Research
IED	Independent Exploratory Development
IR	Infrared
ITSS	Intelligent Tutoring Systems
ITS	Intelligent Tutoring System
I/ITSC	Interservice/Industry Training Systems Conference
ISAR	Inverse Synthetic Aperture Radar
MMI	Man-Machine Interface
M-DDS	Mini-Display and Debrief System
NAVTRASYSCEN	Naval Training Systems Center
NVG	Night Vision Goggles
RI	Radio Instruments
RF	Radio Frequency
RIOT	Radio Instruments Orientation Trainer
RISC	Reduced Instruction Set Computer
RDA	Research, Development and Acquisition
R&E	Research and Engineering
SAGES	ScenArio Generation Expert System
SPMS	Simulator Performance Monitoring System
SBIR	Small Business Innovative Research
SNA	Student Naval Aviators
SAR	Synthetic Aperture Radar
TACTS	Tactical Aircrew Combat Training System
TACTICS	Tactical Training Instructor Components
UCI	User/Computer Interfaces
VE	Virtual Environment